Physiotherapy rehabilitation for Whiplash Associated Disorder II: a systematic review and meta-analysis of Randomised Controlled Trials

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2011-000265
Article Type:	Research
Date Submitted by the Author:	26-Jul-2011
Complete List of Authors:	Rushton, Alison; University of Birmingham, School of Health and Population Sciences, College of Medical and Dental Sciences Wright, Chris; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Heneghan, Nicola; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Eveleigh, Gillian; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Calvert, Melanie; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Freemantle, Nick; UCL, PCPH
Primary Subject Heading:	Rehabilitation medicine
Keywords:	Physiotherapy, Whiplash injury, Systematic review

COVER LETTER

19th July 2011

Dear Sir / Madam

Re: Physiotherapy rehabilitation for Whiplash Associated Disorder II: a systematic review and meta-analysis of Randomised Controlled Trials

Our above titled paper has been submitted to BMJ Open for consideration for publication. The paper presents a systematic review and meta-analysis collating evidence to the end of December 2010 and is reported in line with the PRISMA statement.

With 40-60% patients experiencing chronic symptoms post whiplash injury, there are consequent major societal and economic implications. Effective management of patients presenting with Whiplash Associated Disorder is therefore an important issue for General Practitioners, Consultants, Physiotherapists and other healthcare professionals.

Our paper evaluates effectiveness of physiotherapy intervention post Whiplash Associated Disorder II, which currently is unclear. Whiplash Associated Disorder II represents approximately 93% patients presenting for management post whiplash injury.

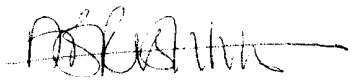
Individuality of this review is characterised by a focus to physiotherapy outpatient care for Whiplash Associated Disorder II, including trials to the end of December 2010. Since it is unethical to include large numbers of patients in poorly conducted trials, we feel that the results require broad dissemination to promote support for a well designed and properly powered trial, focused to the Whiplash Associated Disorder II population.

There have been no previous publications from the same study.

The study is not funded or sponsored by industry, and the paper is not written by a professional medical writer.

I look forward to hearing your evaluation of the paper's suitability for BMJ Open.

Yours sincerely



Dr Alison Rushton
Senior Lecturer Physiotherapy. EdD. MSc. Grad Dip Phys. Dip TP. mILT. FMACP.

TITLE PAGE

Title: Physiotherapy rehabilitation for Whiplash Associated Disorder II: a systematic review and meta-analysis of Randomised Controlled Trials

Authors: Rushton A, Wright C, Heneghan N, Eveleigh G, Calvert M, Freemantle N

Dr Alison Rushton
Senior Lecturer Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Mrs Chris Wright
Senior Lecturer, Nursing and Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Mrs Nicola Heneghan
Lecturer, Nursing and Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Mrs Gillian Eveleigh
Senior Lecturer, Nursing and Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Dr Melanie Calvert
Senior Lecturer
School of Health and Population Sciences
College of Medicine and Dentistry
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Professor Nick Freemantle
Professor of Clinical Epidemiology& Biostatistics
Department of Primary Care and Population Health

Upper Third Floor
UCL Medical School (Royal Free Campus)
Rowland Hill Street
London
NW3 2PF

ADDRESS FOR CORRESPONDENCE:
Address a/a

Alison Rushton

Email: a.b.rushton@bham.ac.uk
Tel: 0121 415 8597

Competing Interest Declaration

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that (1) [initials of relevant authors] have support from [name of company] for the submitted work; (2) [initials of relevant authors] have [no or specified] relationships with [name of companies] that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have [specified] financial relationships that may be relevant to the submitted work; and (4) [initials of relevant authors] have no [or specified] non-financial interests that may be relevant to the submitted work.

Sources of funding

No funding was received to support this work.

Contributors

Contributors: AR and GE are Senior Lecturers in Physiotherapy and NH is a Lecturer. MC and CW are both Senior Lecturers. NF is Professor of Clinical Epidemiology and Biostatistics. AR, MC, CW and NF have longstanding professional interests in the quality and reporting of randomised controlled trials in medicine and physiotherapy. AR, NH and GE have a professional focus to musculoskeletal physiotherapy. AR and CW were responsible for the conception of the study. All authors have contributed to the systematic review and have been involved in developing the content of the article. AR wrote the first draft of the paper and developed it initially with CW. AR has worked with all authors reworking content into subsequent drafts. All authors gave final approval of the version to be published. AR is the guarantor.

ABSTRACT

Objective

To evaluate effectiveness of physiotherapy management in patients experiencing Whiplash Associated Disorder II, on clinically relevant outcomes in the short and longer term.

Design

Systematic review and meta-analysis. Two reviewers independently searched information sources, assessed studies for inclusion, evaluated risk of bias, and extracted data. A third reviewer mediated disagreement. Assessment of risk of bias was tabulated across included trials. Quantitative synthesis was conducted on comparable outcomes across trials with similar interventions. Meta-analyses compared effect sizes, with random effects as primary analyses.

Data sources

Pre-defined terms were employed to search electronic databases. Additional studies were identified from key journals, reference lists, authors and experts.

Eligibility criteria for selecting studies

RCT published in English before 31/12/2010 evaluating physiotherapy management of patients (>16 years), experiencing Whiplash Associated Disorder II. Any physiotherapy intervention was included, when compared with other types of management, placebo/sham, or no intervention. Measurements reported on ≥1 of the following outcomes were included: disability, function and health.

Results

21 RCTs (2126 participants, 9 countries) were included. Interventions were categorised as active physiotherapy or a specific physiotherapy intervention. 20/21 trials were evaluated as high risk of bias and 1 as unclear. 1395 participants were incorporated in the meta-analyses on 12 trials. In evaluating short term outcome in the acute/sub-acute stage, there was some evidence that active physiotherapy

intervention reduces pain and improves range of movement, and that a specific physiotherapy intervention may reduce pain. However, moderate/considerable heterogeneity suggested that treatments may differ in nature or effect in different trial patients. Differences between participants, interventions, and trial designs limited potential meta-analyses.

Conclusions

Inconclusive evidence exists for the effectiveness of physiotherapy management for Whiplash Associated Disorder II. There is potential benefit for improving range of movement and pain short term through active physiotherapy, and for improving pain through a specific physiotherapy intervention.

Article summary

Article focus

- Physiotherapy intervention is recommended in Whiplash Associated Disorder II, although the most beneficial intervention and the effectiveness of physiotherapy management are unclear.
- Systematic reviews have not focused on Whiplash Associated Disorder II that represents approximately 93% patients presenting for management post whiplash injury.
- The objective of this systematic review was to evaluate the effectiveness of physiotherapy management in patients experiencing Whiplash Associated Disorder II, on clinically relevant outcomes in the short and longer term.

Key messages

- This systematic review demonstrates inconclusive poor quality evidence for the effectiveness of physiotherapy management for Whiplash Associated Disorder II.
- There is potential benefit for improving pain and range of movement short term through active physiotherapy and for improving pain through specific physiotherapy interventions.
- This potential benefit merits further consideration in a properly powered clinical trial with attention to ensure low risk of bias.

Strengths and limitations of this study

- The strengths of this review are its focus to physiotherapy intervention and the most common Whiplash Associated Disorder II classification requiring physiotherapy intervention.
- A limitation is that differences between participants, interventions, and trial designs limited potential meta-analyses.

- Surprisingly, no chronic interventions were comparable for analysis, considering the high number of patients experiencing chronicity with Whiplash Associated Disorder.

INTRODUCTION

Road traffic accidents are the primary cause of whiplash, a soft tissue injury to the neck following an acceleration-deceleration mechanism of injury.[1] The cumulative incidence of patients seeking healthcare post whiplash from a road traffic accident has increased during the last 30 years to recent estimates of >3 in 1000 inhabitants in North America and Western Europe[2] and 1.0-3.2/1000 inhabitants in Sweden.[3] In the UK, insurance statistics indicate that 300,000 patients present per annum with Whiplash Associated Disorders.[4] Whiplash Associated Disorders are the resulting clinical presentations following the injury and can range in severity, clinical symptoms and physical findings.[1] Many patients with Whiplash Associated Disorders experience persistent pain and disability, with reports suggesting that 40-60% of those injured have chronic symptoms.[5 6 7 8] The annual economic costs associated with management of Whiplash Associated Disorders and associated time off work is estimated as $3.9 billion in the US,[9] and €10 billion in Europe.[10]

Patients experiencing Whiplash Associated Disorders may be regarded as a distinct group within the broader non-specific neck pain population.[1 2 7 11 12 13] Whiplash Associated Disorders can be categorised as grade 0 to IV,[1] where a higher grade indicates increased severity. The classification system is widely used in clinical practice[14] and guidelines.[15] Patients with Whiplash Associated Disorder II who experience neck pain accompanied by stiffness or tenderness, and musculoskeletal sign(s), for example a reduced range of available movement, form the major group of patients (93.4%)[14] who might benefit from conservative management; commonly involving physiotherapy intervention. A recent best evidence synthesis[3] recommended a focus of research to the most common Whiplash Associated Disorder I and II classifications, excluding classification III and above (i.e. patients with neurological signs and fracture and/or dislocation) and classification 0 (no complaint at the neck, and no physical signs).[1] However, a classification of Whiplash Associated Disorder I is less commonly seen by physiotherapists as there are no accompanying physical findings (neck pain, stiffness or tenderness but with no physical findings) and patients are known to recover within 6 months post injury.[14]

Evidence of the effectiveness of physiotherapy intervention for the treatment of Whiplash Associated Disorder II is scarce. Existing systematic reviews instead tend to focus on a range of Whiplash Associated Disorder classifications, a broad range of conservative intervention strategies such as educational videos, include studies of non traumatic neck pain, and lack rigorous assessment of the risk of bias of included studies. The most robust evidence, a Cochrane review,[16] on the management of Whiplash Associated Disorder I/II patients does not specifically assess physiotherapy. No review has included trials published post 2006. The effectiveness of physiotherapy for the Whiplash Associated Disorder II population is therefore unclear.

Objectives

To investigate the short and longer term effectiveness of physiotherapy outpatient management of patients presenting with Whiplash Associated Disorder II, in terms of disability, function and health,[17] in patients aged >16 years.

MATERIALS AND METHODS

A systematic review was conducted according to a pre-defined protocol based on the method guidelines by the Back Review Group of the Cochrane Collaboration[18] and the Cochrane handbook.[19] It is reported in line with the PRISMA statement.[20]

Eligibility criteria

S*tudies*: RCTs evaluating the effectiveness of physiotherapy outpatient management of patients experiencing Whiplash Associated Disorder II. Studies not written in English were excluded rather than restricting the inclusion of studies, thereby providing information of potential bias.[21] No restrictions were placed on publication date.

Participants: Patients who had experienced a whiplash injury and were classified as Whiplash Associated Disorder II, aged >16 years. Acute and chronic presentations were included and analysed separately.

Interventions: Any physiotherapy outpatient management intervention.

Outcome measures: Disability, function and health,[17] in the short term (approximately 3 months post injury/intervention) and/or longer term (approximately 12 months).

Information sources

Each database was searched using sensitive topic based search strategies to the end of December 2010:

- The Cochrane Library: Controlled Trials Register, Health Technology Assessment Database, NHS Economic Evaluation Database.
- CINAHL, EMBASE, MEDLINE, PEDro, ZETOC databases
- Selected Internet sites and Indexes: Turning Research into Practice, Health Services/Technology Assessment, PUBMED.
- National Research Register, Current Controlled Trials website (York).

- Cochrane Back Review Group.
- Cochrane Cervical Overview Group.
- Hand searches in key journals e.g. Spine, Manual Therapy, Physiotherapy, Physical Therapy, Australian Journal of Physiotherapy.
- Science Citation Index and Social Science Citation Index.
- Unpublished research:[21] British National Bibliography for Report literature, Dissertation Abstracts, Index to Scientific and Technical Proceedings, National Technical Information Service, System for Information on Grey Literature.
- Personal citation for key authors in the field.

Search

The search employed pre-defined terms. Table 1 provides two examples of the searches utilised.

[Insert Table 1 near here]

Study selection

Two subject experts independently searched information sources (GE/NH), and independently assessed identified studies for inclusion by grading each criterion (Table 2) as eligible/not eligible/might be eligible.[18] A study was potentially relevant and its full text was obtained, when it could not be unequivocally excluded on the basis of its Title and Abstract[21] following discussion between the two independent reviewers. In a situation of disagreement or when abstracts contained insufficient information the full text was obtained. A study was included in the review when both reviewers independently assessed it as satisfying the inclusion criteria from the full text. If agreement was not obtained, a third reviewer (AR, subject and methodological expert) mediated following discussion.[18]

[Insert Table 2 near here]

Risk of bias was independently assessed by the same reviewers for each included study. Risk of bias, and homogeneity of participants, interventions, and outcomes were key considerations informing the potential for including trials in meta-analyses, in line with Cochrane.[19] The third reviewer again mediated.[19] Agreement between reviewers was evaluated using Cohen's Kappa.[22] All processes and tools were piloted.

Data collection process

Two reviewers (AR/CW) independently extracted the data[19 23] using a standardised form. A third independent reviewer (NH) checked for consistency and clarity.

Data items

Data extracted for each trial included: design, participants and indication, Whiplash Associated Disorder categorisation, interventions, study setting, outcome measures, timing of assessments, power calculations, loss to follow up, intention to treat analyses and main results. Key outcome measures were pre-defined as valid tools to measure pain, disability, function, physical impairment, social impact and patient satisfaction, reflecting domains from the International Classification of Functioning, Disability and Health.[17] Based on recommendations, a maximum of two primary outcomes were considered acceptable,[24] when more than one primary outcome was reported and alpha spend was not considered.

Risk of bias in individual studies

The Cochrane 'risk of bias' assessment tool was used to appraise the internal validity of each included trial.[25] In contrast to the majority of quality scales used in health research,[20 26 27] the Cochrane tool is informed by empirical research.[25] Each component of bias was reported independently and considered with regard to each key outcome measure.[25 28] The component including 'blinding' the treating therapist

has been acknowledged as generally impossible[25] and this formed part of the appraisal by the reviewers as the Cochrane tool also permits evaluation of the likely influence of any lack of blinding.

Summary measures

Quantitative synthesis was conducted in line with the protocol on comparable key outcomes across trials evaluating similar interventions (nature of intervention, and timing of assessments at approximately 3 months and/or 12 months post injury or intervention). Results were reported in the context of overall risk of bias. Comparable outcomes were defined as tools developed to measure the same underlying domain. Two subject experts and two methodological experts identified the combinations of studies and outcomes on which to conduct meta-analyses.

Using RevMan,[29] meta-analyses compared standardised differences in means using DerSimonian-Laird random effects[30] for the principal analyses to allow for systematic differences in effects estimated across the included trials.[21 30] 95% confidence intervals were reported for summary statistics. Standardised mean differences were selected to make comparisons across studies that used different tools to measure the same outcome,[21] or reported a mixture of final value scores and change from baseline scores. Hedges-Olkin fixed effects[31] were used as the supportive analyses.

Planned methods of analysis

Data were requested from all authors, except for those with no comparability of outcome measures to other trials.[32 33] Data defined by Whiplash Associated Disorder classification was also requested from all authors of trials that reported combined Whiplash Associated Disorder classifications. Analyses were conducted on final summary statistics when reported or the raw data where supplied. When necessary, standard deviations were estimated from reported confidence intervals or percentiles.[34] In-line with the

use of random effects as primary analyses,[30] change scores were used for studies when no other data were forthcoming. Heterogeneity in treatment effects was evaluated through computation of I^2.

Risk of bias across studies

A summary assessment for risk of bias was tabulated across studies, and consensus agreed concerning the overall potential risk of bias. It was not helpful to attempt to assess potential publication bias visually using Funnel plots[21] as less than 10 trials were included in meta-analyses.[35]

Additional analyses

No post hoc supportive analyses were conducted owing to the inconsistency of outcome measures across the trials.

RESULTS

Study selection

Included trials were grouped according to the Whiplash Associated Disorder classification[1] into 5 categories:

Whiplash Associated Disorder II: 5 articles and 5 trials,[33 36 27 38 39] from 4 countries were included.

Whiplash Associated Disorders I/II: 8 articles and 8 trials,[40 41 42 43 44 45 46 47] from 6 countries were included.

Whiplash Associated Disorders II/III: 4 articles and 4 trials,[32 48 49 50] from 3 countries were included.

Whiplash Associated Disorders 0/I/II: 3 articles and 2 trials,[51 52 53] from 2 countries were included.

Whiplash Associated Disorders I/II/III: 3 articles and 2 trials,[54 55 56] from 1 country were included.

Most retrieved trials were published in English with only 2 in other languages. One relevant unpublished study was found (Managing Injuries of the Neck Trial, accessible at http://www.hta.ac.uk/1399 due to be published 2011). Figure 1 presents the numbers of studies at each stage of selection. Complete inter-reviewer agreement was achieved on study inclusion across all categories following discussion.

[Insert Figure 1 here]

Study characteristics

Descriptive data for the 21 included trials are summarised in Table 3.

[Insert Table 3 near here]

Methods

Eighteen trials randomised participants across 2 groups, 1 trial across 3 groups, and 2 trials across 4 groups. Eight trials compared a specific physiotherapy intervention, for example manipulation, to no management, sham or placebo. Thirteen trials compared an active physiotherapy intervention to

standard care, and the active approaches were characterised by additional interventions, a multimodal intervention, or a progressive intervention. Duration of interventions ranged from one treatment session to 12 months. The number of assessments varied from 1-4, occurring immediately post treatment to 3 years.

Participants

The 21 trials randomised 2126 participants. Age varied from 16-70 years. 271/2126 participants were randomised in trials focused to Whiplash Associated Disorder II[1]. Of the authors who responded, no authors were able to provide data for their included Whiplash Associated Disorder classifications separately. In the 8 Whiplash Associated Disorder I/II category trials, 934 participants were randomised but no distinction of Whiplash Associated Disorder II participants was possible. In the 4 Whiplash Associated Disorder II/III category trials, 333/409 (81.5%, 2 trials) participants were classified as Whiplash Associated Disorder II, with a further 111 participants (2 trials) with no distinction of Whiplash Associated Disorder II participants possible. In the 2 Whiplash Associated Disorder O/I/II category trials, 302 participants were randomised with no distinction of Whiplash Associated Disorder II participants possible. In the 2 Whiplash Associated Disorder I/II/III category trials, 49/66 (74%, 1 trial) participants were classified as Whiplash Associated Disorder II, with a further 33 participants (1 trial) with no distinction of Whiplash Associated Disorder II participants possible. 1395 participants were randomised in the 12 trials included in the meta-analyses.

Interventions

Eight trials were conducted at single-centres that included physiotherapy clinics or outpatient departments. Both a clinic and home setting were used in 1 trial. The setting was unclear in 12 trials. One trial investigated a group intervention. Interventions could be grouped according to whether they were a specific physiotherapy intervention or an active intervention comprising different components.

[1] In Aigner et al (2006)[36], three subject experts agreed that the Kramer grade II evaluated as equivalent to the WADII classification.

Timing of interventions included acute/sub-acute (13 trials) and chronic stages (8 trials), ranging from 2 days to 15 years post injury.

Primary outcomes

Only 6 (28.5%) trials specified primary outcomes *a priori* that included: Neck Pain and Disability Index, Nociceptive Flexion Reflex, Neck Disability Index, Pain Visual Analogue Scale (VAS), Pain VAS and work activities VAS, and Pain VAS and Disability VAS. One trial[44] specified 3 primary outcome measures with no adjustment for alpha spend and was therefore evaluated as unacceptable in specifying primary outcomes.[24]

Secondary and additional outcomes

Most trials reported some assessment of pain (general or specific to the neck) (15 trials), and range of movement (ROM) (13 trials). Nine trials reported assessment of disability. A wide range of other outcomes included: work status, SF36, Tampa, patient satisfaction, muscle stability, posture, and kinaesthetic sensibility. Two trials reported outcomes that were not consistent with any other trial for example, temperature pain threshold[33] and the tandem standing balance test.[32]

Risk of bias within studies

'Almost perfect'[57] 93% inter-reviewer agreement was achieved on risk of bias assessment prior to discussion (Cohen's Kappa[22] k = 0.90, p<.0005) and 100% agreement was reached following discussion. Only 2 trial protocols were available.[58 59] Of the 21 included trials, 20 were evaluated as high risk of bias and 1 as unclear risk of bias (Table 4). The very high proportion of trials identified as high risk of bias should affect the interpretation of results.[25]

[Insert Table 4 near here]

Risk of bias across studies

Only trials evaluated as high risk of bias were available for meta-analysis. Although reasons for the high risk components provided concern for potential bias, results from meta-analyses evaluated critically within this context enabled an overview of the evidence to be presented, strength of effect to be presented, and tentative conclusions to be proposed to advance research.

Results of individual studies and synthesis of results

Comparability of interventions, timing of assessments and outcome measures were considered to determine appropriate quantitative syntheses of trials.[21] Table 5 compares the compatibility of outcomes for management in the acute/sub-acute and chronic stages; identifying no possible quantitative syntheses within the five categories of Whiplash Associated Disorders. No further information re Whiplash Associated Disorder classification was provided by authors to assist potential comparisons re Whiplash Associated Disorder II. In comparing across categories, no comparison was possible for intervention in the chronic stage or long term. The following meta-analyses were conducted in the acute/sub-acute stage in the short term:

- Active intervention v standard intervention for: pain, 4-12 weeks (n=6 trials); ROM flexion/extension (flex/ext), 12 weeks (n=3 trials); ROM rotation (Rot), 12 weeks (n=4); ROM side flexion (SF), 12 weeks (n=3); Total ROM, 4-12 weeks (n=3)[2]; Disability, 6-12 weeks (n=5).
- Specific intervention v control post intervention for: pain (n= 4 trials)[3]; ROM flex/ext, ROM Rot, and ROM SF (n=3 trials)[4].

Active versus standard intervention short term:

[2] Excluded Rosenfeld et al (2003;2006)[51 52] as short term assessment was 6 at months.
[3] Included Thuile and Walzl (2002)[45] although timing of intervention and assessment was unclear from trial.
[4] Aigner et al[36] n=5 LTFU but not clear from which group.

Evidence from 2 trials[37 46] suggested that intervention might reduce pain, with active intervention being beneficial compared to standard intervention (Figure 2). This was not supported by 4 trials.[40 43 53 54] The pooled random effects (-0.35, 95%CI -0.63 to -0.07) did support evidence of an effect short term. Evidence from 1 trial[41] suggested that intervention might improve ROM flex/ext and ROM SF, with active intervention being beneficial compared to standard intervention (Figures 3 and 4). This was not supported by 2 trials.[40 43] The pooled random effects (ROM flex/ext: 0.39, 95%CI 0.04 to 0.74; ROM SF: 0.45, 95%CI 0.17 to 0.73) did support evidence of an effect short term. Evidence from 3 trials[41 43 54] suggested that intervention might improve ROM Rot, with active intervention being beneficial compared to standard intervention (Figure 5). This was not supported by 1 trial.[40] The pooled random effects (0.68, 95%CI 0.38 to 0.99) did support evidence of an effect short term.

Overall, there was no evidence of short term benefit of active over standard intervention on total ROM (pooled random effects 0.28, 95%CI -0.03 to 0.59) or disability (Figure 6: -0.26, 95%CI -0.57 to 0.05).

[Insert Figures 2-6 near here]

Specific physiotherapy intervention versus control:

Evidence from 4 trials [38 45 49 50] suggested that intervention might reduce pain short term, with specific physiotherapy intervention being beneficial compared to control. The pooled random effects (-2.11, 95%CI -3.85 to -0.36) did support evidence of an effect short term. Overall, there was no evidence of short term benefit of specific physiotherapy intervention over control on ROM flex/ext (pooled random effects 0.83, 95%CI -3.79 to 5.44) or ROM Rot (pooled random effects -1.02, 95%CI -3.73 to 1.68) or ROM SF (pooled random effects -1.21, 95%CI -3.11 to 0.69).

DISCUSSION

Summary of evidence

Evidence was assessed from 21 RCTs (2126 participants) conducted across 9 countries. Only 1 trial investigated a group intervention. Interventions were grouped into active v standard intervention, and specific physiotherapy intervention versus control. No meta-analyses were possible on a Whiplash Associated Disorder II population, as most trials included combined classifications of Whiplash Associated Disorders in their populations. Disappointingly, as many trials were recent, 20/21 trials were assessed as high risk of bias, and 1 as unclear risk. All 12 trials (1395 participants from 6 countries) included in the meta-analyses were assessed as high risk. Comparable outcomes across trials included pain, ROM flex/ext, ROM Rot, ROM SF, total ROM, and disability in the short term. There was no evidence beyond individual results of benefit in the longer term as no meta-analyses were possible. The one trial that evaluated as unclear risk of bias was, therefore, not included in any meta-analyses.[39]

In evaluating short term outcome in the acute/sub-acute stage, there was some evidence that active physiotherapy intervention reduces pain. This was supported by statistically significant differences in 2 trials.[37 46] Although the finding is interesting, further trials are required since one trial possessed one high risk component of bias and the other two. Only 1 trial[41] suggested that active physiotherapy intervention changes ROM (flex/ext and SF), and 3 trials[41 43 54] suggested a change in ROM Rot. There was evidence from the meta-analyses to support this. Again, risk of bias was high for all trials, with two high risk components for one trial[41] and one high risk component for the two other trials. There was no evidence that active physiotherapy intervention affects disability.

In evaluating short term outcome in the acute/sub-acute stage, there was some evidence that specific physiotherapy intervention reduces pain. This was supported by statistically significant differences found in 4 trials[38 45 49 50] using interventions of Kinesio Taping, magnetic therapy and manipulation.

Although the finding is interesting, further trials are required because all trials possessed one high risk component of bias and two trials had an additional 4 unclear risks. Only one individual trial[45] suggested that specific physiotherapy intervention (magnetic therapy) changes ROM (flex/ext or Rot or SF) in the short term. There was no evidence from the meta-analyses to support this.

Limitations

The strengths of this review are its focus to physiotherapy intervention and the most common Whiplash Associated Disorder II classification requiring physiotherapy intervention. Heterogeneity in treatment effects can be explained by variation in the quality of administration of interventions. Differences were evident in the classification of Whiplash Associated Disorder participants, outcome measures and assessment points. Differences in components of the physiotherapy interventions were also evident with some variation explained by diversity in practice across countries. The differences limited the possible comparisons in the meta-analyses. Surprisingly, no chronic interventions were comparable for analysis, considering the high number of patients experiencing chronicity with Whiplash Associated Disorder.[7 8] Also surprisingly, work status was not possible for analysis considering the economic implications of Whiplash Associated Disorder.[9 10]

Moderate heterogeneity (I^2 57%) was present in the evidence for active intervention for pain[34] identifying significant difference in treatment effects between trials. However, heterogeneity might not be important for ROM flex/ext, Rot, and SF (I^2 31%, 25%, 0% respectively). Substantial heterogeneity (I^2 64%) was present in the evidence for active intervention for disability perhaps explaining no evidence of an effect. Considerable heterogeneity[34] was present in the evidence for specific physiotherapy intervention for pain, ROM flex/ext, Rot, and SF (I^2 98.1%, 99.0%, 98.1%, and 96.6% respectively), perhaps explaining no evidence of an effect for all ROM evaluations. This anticipated heterogeneity was accounted for by using the random effects model.

The limitations in the context of the high risk of bias and number of trials available necessitate urgent attention to focus a future high quality and properly powered trial to evaluate a Whiplash Associated Disorder II population. The poor quality of trials is consistent with earlier findings for physiotherapy management post lumbar discectomy.[60] There is limited scope at present for good quality meta-analyses in physiotherapy with rigorous and well reported trial inclusion. Physiotherapy trials need to avoid risk of bias. Planning for quality is important, particularly for issues that present known problems for physiotherapy trials, for example loss to follow up. Consensus for minimum core sets of outcome measures for specific populations is also required.

Conclusions

This systematic review has identified inconclusive poor quality evidence for the effectiveness of physiotherapy management for Whiplash Associated Disorder II. Inclusion of large numbers of participants in the poorly designed trials published to date is unethical. Best practice for physiotherapy management, therefore, remains unclear. This lack of clarity might explain the variability of interventions across the trials that made comparability of interventions difficult. There is potential benefit for improving pain and ROM flex/ext, Rot, and SF short term through active physiotherapy and for improving pain through specific physiotherapy interventions. This potential benefit merits further consideration in a properly powered clinical trial with attention to ensure low risk of bias.

Funding

No funding was received to support this work.

References

1. Spitzer W, Skovron M, Salmi L Cassidy JD, Duranceau J, Suissa S et al. (1995) Scientific monograph of the Quebec task force on whiplash associated disorders: redefining 'whiplash' and its management. Spine 1995;20(8):1S-73S .

2. Holm LW, Carroll LJ, Cassidy JD, Hogg-Johnson S, Cote P, Guzman J et al. The burden and determinants of neck pain in Whiplash Associated Disorders after traffic collisions, results of the Bone and Joint Decade 2000-2010 Task Force on Neck pain and its Associated Disorders. Spine 2008;33(45):S52-S59.

3. The Swedish Society of Medicine and the Whiplash Commission Medical Task Force. Whiplash Injuries: Diagnosis and early management. European Spine Journal 2008;17(Suppl3):S359-S418.

4. Burton. Treatment guidelines: is there a need? In: Proceedings of Whiplash conference 2003, Bath, England, 6-8th May. Bristol: Lyons Davidson Solicitors; 2003.

5. Barnsley L, Lord S, Bogduk N. Whiplash injury: clinical review. Pain 1994;58:283-307.

6. Scholten-Peeters GGM, Verhagen AP, Bekkering GE, van der Windt DAWM, Barnsley L, Oostendorp RAB et al. Prognostic factors of whiplash-associated disorders: a systematic review of prospective cohort studies. Pain 2003;104:303e22.

7. Carroll LJ, Hurwitz EL, Cote P, Hogg-Johnson S, Carragee EJ, Nordin M et al. Research priorities and methodological implications. The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and its Associated Disorders. Spine 2008;33(4S):S214-S220.

8. Kampner SJ, Rebbeck TJ, Maher CG, McAuley JH, Sterling M. Course and prognostic factors of whiplash: a systematic review and analysis. Pain 2008;138:617-629.

9. Eck JC, Hodges SD, Humphreys SC. Whiplash: a review of a commonly misunderstood injury. The American Journal of Medicine 2001;110(8):651-6.

10. Galasko CSB, Murray P, Stephenson W. Incidence of whiplash-associated disorder. BC Med J 2002;44:237-40.

11. Field S, Treleaven J, Jull G. Standing balance: a comparison between idiopathic and whiplash-induced neck pain. Man Ther 2008;13(3):183e91.

12. Chien A, Sterling M. Sensory hypoaesthesia is a feature of chronic whiplash but not chronic idiopathic neck pain. Man Ther 2010;15(1):48e53.

13. Woodhouse A, Liljebäck P, Vasseljen O. Reduced head steadiness in whiplash compared with non-traumatic neck pain. J Rehabil Med 2010; 42(1):35e41.

14. Sterling M. A proposed new classification system for whiplash associated disorders—implications for assessment and management. Manual Therapy 2004;9:60–70.

15. Moore A, Jackson A, Jordan J, Hammersley S, Hill J, Mercer C et al. Clinical guidelines for the physiotherapy management of Whiplash Associated Disorder (WAD). Chartered Society of Physiotherapy, London, 2005.

16. Verhagen AP, Scholten-Peeters GGGM, van Wijngaarden S, de Bie R, Bierma-Zeinstra SMA. Conservative treatments for whiplash. Cochrane Database of Systematic Reviews 2007, Issue 2. Art. No: CD003338. DOI: 10.1002/14651858.CD003338.pub3.

17. World Health Organisation. International Classification of Functioning, Disability and Health: ICF. Geneva, Switzerland: World Health Organisation, 2001.

18. van Tulder M, Furlan A, Bombardier C, Bouter L, and the Editorial Board of the Cochrane Collaboration Back Review Group. Updated method guidelines for systematic reviews in the Cochrane Collaboration back review group. Spine 2003;28:1290-1299.

19. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

20. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097 2009; doi:10.1371/journal.pmed1000097

21. Centre for Reviews and Dissemination [CRD]. Systematic reviews: CRD's guidance for undertaking reviews in healthcare, 3rd edition, CRD University of York, York Publishing Services Ltd, 2009.

22. Cohen J. A coefficient of agreement for nominal scales. Educational and Psychological Measurement 1960;20:37-46.

23. Higgins JPT, Deeks JJ (editors). Chapter 7: Selecting studies and collecting data. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

24. Machin D, Fayers PM. Randomized Clinical Trials: design, practice and reporting. Wiley- Blackwell. West Sussex. 2010.

25. Higgins JPT, Altman DG, Sterne JAC (editors). Chapter 8: Assessing risk of bias in included studies. In. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

26. Jüni P, Witschi A, Bloch R, Egger M. The hazards of scoring the quality of clinical trials for meta-analysis. JAMA 1999;282(11):1054-1060.

27. Katrak P, Bialocerkowski AE, Massy-Westropp N, Kumar VSS, Grimmer A. A systematic review of the content of critical appraisal tools. BMC Medical Research Methodology 2004;4:22

28. Olivio SA, Macedo LG, Gadotti IC, Fuentes J, Stanton T, Magee DJ. Scales to Assess the Quality of Randomized Controlled Trials: A Systematic Review. Physical Therapy 2008;88:156-175.

29. Green S, Higgins JPT (editors). Chapter 2: Preparing a Cochrane review. In Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

30. DerSimonian R, Laird N. Meta-analyses in clinical trials. Controlled Clinical Trials 1986;7:177-188.

31. Hedges LV, Olkin I. Statistical methods for meta-analyses. Academic Press Inc. San Diego, 1985.

32. Hansson EE, Mansson NO, Ringsberg KAM, Hakansson A. Dizziness among patients with whiplash-associated disorder: a randomised controlled trial, Journal of Rehabilitative Medicine. 2006;38:387-390.

33. Sterling M, Pedler A, Chan C, Puglisi M, Vuvan V, Vicenzino B. Cervical lateral glide increases nociceptive flexion reflex threshold but not pressure or thermal pain thresholds in chronic whiplash associated disorders: a pilot randomised controlled trial. Manual Therapy 2010;15:149-153.

34. Deeks JJ, Higgins JPT, Altman DG (editors). Chapter 9: Analyzing data and undertaking meta-analyses. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

35. Sterne JAC, Egger M, Moher D on behalf of the Cochrane Bias Methods Group. Chapter 10: Addressing reporting biases. In. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

36. Aigner N, Fialka C, Radda C, Vecsei V. Adjuvant laser acupuncture in the treatment of whiplash injuries: a prospective, randomized placebo-controlled trial, Weiner Klinische Wochenschrift, The Middle European Journal of Medicine 2006;118(3/4):95-99.

37. Dehner C, Elbel M, Strobel P, Scheich M, Schneider F, Krischak G, Kramer M (2009). Grade II whiplash injuries to the neck: what is the benefit for patients treated by different physical therapy modalities? Patient Safety in Surgery 3(2).

38. Gonzalez-Inglesias J, Fernandez-de-las-Penas C, Cleland J, Huijbregts P, Gutierrez-Vega MDR. Short-term effects of cervical kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: a randomized clinical trial. Journal of Orthopaedic and Sports Physical Therapy 2009;39(7):515-521.

39. Jull G, Sterling M, Kenardy J, Beller E. Does the presence of sensory hypersensitivity influence outcomes of physical rehabilitation for chronic whiplash? A preliminary RCT. Pain 2007;129:28-34.

40. Ask T, Strand LI, Skouen JS. The effect of two exercise regimes; motor control versus endurance / strength training for patients with whiplash-associated disorders: a randomized controlled pilot study. Clinical Rehabilitation 2009;23:812-823.

41. Bonk AD, Ferrari R, Giebel GD, Edelmann M, Huser R. Prospective, randomized, controlled study of activity versus collar, and the natural history for whiplash injury, in Germany. Journal of Musculoskeletal Pain 2000;8(1/2):123-132.

42. Pato U, Di Stefano G, Fravi N, Arnold M, Curatolo M, Radanov BP, Ballinari P, Sturzenegger M. Comparison of randomized treatments for late whiplash. Neurology 2010;74:1223-1230.

43. Scholten-Peeters GGM, Neeleman-van der Steen CWM, van der Windt DAWM, Hendriks EJM, Verhagen AP, Oostendorp RAB. Education by general practitioners or education with exercises by physiotherapists for patients with whiplash-associated disorders? A randomized clinical trial. Spine 2006;31(7):723-731.

44. Stewart MJ, Maher CG, Refshauge KM, Herbert RD, Bogduk N, Nicholas M. Randomized controlled trial of exercise for chronic whiplash-associated disorders, Pain 2007;128:59-68.

45. Thuile C, Walzl M. Evaluation of electromagnetic fields in the treatment of pain in patients with lumbar radiculopathy or the whiplash syndrome. Neurorehabilitation 2002;17:63-67.

46. Vassiliou T, Kaluza G, Putzke C, Wulf H, Schnabel M. Physical therapy and active exercises – an adequate treatment for prevention of late whiplash syndrome? Randomized controlled trial in 200 patients. Pain 2006;124:69-76.

47. Vikne J, Oedegaard A, Laerum E, Ihlebaek C, Kirkesola G. A randomized study of new sling exercise treatment vs traditional physiotherapy for patients with chronic whiplash-associated disorders with unsettled compensation claims. Journal Rehabilitation Medicine 2007;39:252-259.

48. Armstrong BS, McNair PJ, Williams M. Head and neck position sense in whiplash patients and healthy individuals and the effect of the cranio-cervical flexion action, Clinical Biomechanics 2005;20:675-684.

49. Fernandez-de-las-Penas C, Fernandez-Carnero J, Fernandez AP, Lomas-Vega R, Miangolarra-Page JC. Dorsal manipulation in whiplash injury treatment: a randomised controlled trial, Journal of Whiplash and Related Disorders 2004a;3(2):55-72.

50. Fernandez-de-las-Penas C, Fernandez-Carnero J, Palomeque del Cerro L, Miangolarra-Page JC. Manipulative treatment vs conventional physiotherapy treatment in whiplash injury: a randomised controlled trial, Journal of Whiplash and Related Disorders 2004b;3(2):73-90.

51. Rosenfeld M, Seferiadis A, Carlsson J, Gunnarsson R. Active intervention in patients with whiplash associated disorders improves long term prognosis. Spine 2003;28(22):2491-2498.

52. Rosenfeld M, Seferiadis A, Gunnarsson R. Active involvement and intervention in patients exposed to whiplash trauma in automobile crashes reduces costs. Spine 2006;31(16):1799-1804.

53. Schnabel M, Ferrari R, Vassiliou T, Kaluza G. Randomised, controlled outcome study of active mobilisation compared with collar therapy for whiplash injury. Emergency Medicine Journal 2004;21:306-310.

54. Soderlund A, Olerud C, Lindberg P. Acute whiplash-associated disorders (WAD): the effects of early mobilization and prognostic factors in long-term symptomatology. Clinical Rehabilitation 2000;14:457-467.

55. Soderlund A, Lindberg P. Cognitive behavioural components in physiotherapy management of chronic whiplash associated disorders (WAD) – a randomised group study. Physiotherapy Theory and Practice 2001;17:229-238.

56. Soderlund A, Lindberg P. Cognitive behavioural components in physiotherapy management of chronic whiplash associated disorders (WAD) – a randomised group study. Giornale Italiano di Medicina del Lavoro ed Ergonomia 2007;29(1): A5-A11.

57. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159-174.

58. Scholten-Peeters GGM, Verhagen AP, Neeleman-van der Steen CWM, Hurkmans JCAM, Wams RWA, Oostendorp RAB. Randomized clinical trial of conservative treatment with whiplash-associated disorders: considerations for the design and dynamic treatment protocol. Journal of Manipulative and Physiological Therapeutics 2003;26(7):412-420.

59. Stewart MJ, Maher CG, Refshauge KM, Herbert RD, Bogduk N, Nicholas M. Advice or exercise for chronic whiplash-associated disorders? Design of a randomized controlled trial, BMC Musculoskeletal Disorders 2007;4:18.

60. Rushton A, Wright C, Goodwin P, Calvert M, Freemantle N. Physiotherapy rehabilitation post first lumbar discectomy: a systematic review and meta-analysis of Randomised Controlled Trials, Spine 2011.eprint, Jan 8.DOI: 10.1097/BRS.0b013e3181f0e8f8.

Table 1: Examples of search strategies

	Medline (Ovid) 1948 – 31st December, 2010
1	acute whiplash or cervical spine disorder or cervical spine injury.mp
2	manual therapy or manipulation or massage.mp
3	clinical trial or randomised controlled trial or RCT.mp
4	1 and 2
5	3 and 4
6	WAD II or whiplash associated disorders or whiplash injury or whiplash patients or whiplash syndrome.mp
7	2 and 6
8	3 and 7
9	Conservative approach or conservative intervention or conservative management or conservative therapy.mp
10	Physical approach or physical intervention or physical management or physical therapy.mp
11	Exercise or active range of motion exercise$ or strengthening exercise$ or stretching exercise$ or therapeutic exercise$ or endurance training or home exercise$ or proprioception exercise$
12	Transcutaneous electrical nerve stimulation or TENS or thermotherapy or electrical stimulation or heat or electrotherapy.mp
13	Pain management program$.mp
14	Patient education or educational or self management program$.mp
15	Posture or (postural and balance) or traction.mp
16	1 and 9
17	3 and 16
18	6 and 9
19	3 and 18
20	1 and 10
21	3 and 20
22	6 and 10
23	3 and 22
24	1 and 11
25	3 and 24
26	6 and 11
27	3 and 26
28	1 and 12
29	3 and 28
30	6 and 12
31	3 and 30
	Embase (Ovid) 1947 – 31st December, 2010
1	acute whiplash or cervical spine disorder or cervical spine injury.mp
2	manual therapy or manipulation or massage.mp
3	clinical trial or randomised controlled trial or RCT.mp
4	1 and 2
5	3 and 4
6	WAD II or whiplash associated disorders or whiplash injury or whiplash patients or whiplash syndrome.mp
7	2 and 6

8	3 and 7
9	Conservative approach or conservative intervention or conservative management or conservative therapy.mp
10	Physical approach or physical intervention or physical management or physical therapy.mp
11	Exercise or active range of motion exercise$ or strengthening exercise$ or stretching exercise$ or therapeutic exercise$ or endurance training or home exercise$ or proprioception exercise$
12	Transcutaneous electrical nerve stimulation or TENS or thermotherapy or electrical stimulation or heat or electrotherapy.mp
13	Pain management program$.mp
14	Patient education or educational or self management program$.mp
15	Posture or (postural and balance) or traction.mp
16	1 and 9
17	3 and 16
18	6 and 9
19	3 and 18
20	1 and 10
21	3 and 20
22	6 and 10
23	3 and 22
24	1 and 11
25	3 and 24
26	6 and 11
27	3 and 26
28	1 and 12
29	3 and 28
30	6 and 12
31	3 and 30

Table 2: Criteria for inclusion and exclusion of studies in the review

	Criteria
Inclusion criteria	
Study Design	RCT
Population	
Age	16 years or older
Subjects	Human; outpatients
Condition	Post whiplash injury
	Experiencing Whiplash Associated Disorder II
Intervention	Conservative physiotherapy outpatient management
Comparison group(s)	At least one comparison group, either placebo / other intervention / no intervention
Outcome	Measurement on at least one of the following outcomes: disability; functional status; physical impairment; impact on social and occupational levels of fitness; pain; quality of life; patient satisfaction
	Measurement of short term outcome (approx 3 months post surgery) and / or long term outcomes (≥1year post surgery)
Time frame	All studies conducted from 1979 onwards
Exclusion criteria	
Study Design	Initial search: • Studies stated as RCTs but do not have a comparison group or random allocation to groups
Participant characteristics	Multiple pathology
	Whiplash Associated Disorder not classified according to severity to provide clarity of Whiplash Associated Disorder II population
Intervention	none
Outcome	none
Language	Full article not written in English

Table 3: Characteristics of eligible RCTs of physiotherapy management post whiplash injury

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
Physiotherapy management Whiplash Associated Disorder (WAD) II						
Aigner et al (2006) Austria Acute	RCT Two groups: A: Laser acupuncture with cervical collar B: Placebo laser with cervical collar Recruitment strategy unclear.	Acute whiplash injury, Kramer grade II (evaluated as equivalent to WAD II), aged 18-65 years with no recent traumatic bone injury cervical region, massive neurological symptoms, recent bone lesions, trauma > 4 days previously, or minor injury who were largely asymptomatic with cervical mobility free in all planes. Baseline (within 4 days of injury): n=50 (8 men, 42 women) A: n=25 B: n=25	***Intervention:*** Both groups: cervical collar for wearing first 1-2 weeks including at night if required (maximum duration 4 weeks), muscle relaxant combined with analgesic. Intervention A or B commenced at first follow up visit and not immediately post baseline. A: Helium Neon laser on 22 traditional needling acupuncture points for 15 seconds each (0.075J/cm^2), for a maximum of 3 times each week for 3 weeks. Duration intervention – mean of 4.6 visits (2-9). B: Externally identical laser device (red lamp) on same acupuncture points and same duration and number of treatments. Duration intervention – mean of 4.5 visits (2-10). ***Setting:*** Unclear	***Short term:*** ROM total flex/ext (cm measure), rotation, and side-flexion (goniometer). ***Long term:*** Duration of condition, neck pain, headaches, dizziness, wearing collar, drug use. Recurrence of myofascial pain, headaches, dizziness. ***Assessments:*** Short term at end of treatment (2-6 weeks post injury) (unclear in article) Long term by postal questionnaire at 8-12 months post injury.	No statistically significant advantage of A for any outcome. No results reported. Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: N=5 (10%) - 2 from A & 3 from B No exclusions No management of losses described Co-interventions not explored No ITT analyses reported
Dehner et al (2009) Germany Acute *Note: Comparison to patients in*	RCT Two groups: A: Active physical therapy B: Passive physical therapy	Acute whiplash injury, < 24 hours post injury, QTF II injury, with no previous injury cervical spine, muscular, neurological or mental disorders, osseous injury, or with no deficit in ROM. Baseline: 1 week post injury.	***Intervention*** ***Both groups:*** NSAIDS and soft cervical collar for 7 days. Post 7 days of collar and medication, patients commenced a standardised programme (A or B) three times per week for seven weeks. A: Soft tissue, trigger point, joint	***Short term (2 months):*** Pain score VAS (100mm): mean of "average degree of pain" and "most severe pain" Deficit in ROM of cervical spine: sum of individual ROM in 6 directions (flex/ext/side-flexion/ rotation) subtracted from pre-	Group A statistically significant greater decrease (p=.009) in median pain score at 2 months	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up:

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
a previous study excluded from extraction from trial report	Recruitment in emergency department.	n=70 patients A: n=35 (n=32 after exclusions due to loss-to follow-up); 10 male, 22 female. B: n=35 (n=32 after exclusions due to loss-to follow-up); 12 male, 20 female.	mobilisation (excluding cervical spine) techniques, posture training, and electrotherapy. Progressed to include: coordination training, training of the trunk and extremities, and stabilisation techniques with short segmental leverage (week 3); three-dimensional training with the head's weight as the limit of resistance (week 6); joint mobilisation cervical spine (week 8). B: Moist heat, classic massage and electrotherapy. ***Setting:*** Physical therapy department	defined normal value (330 degrees). Measured by goniometer. ***Short term (3-6 months):*** Period of disability: days off work Sickness costs: Costs of physical therapy and patient's lost income. ***Assessments:*** Short term: 2 months post injury By telephone after 3-6 months.	No significant inter-group differences on deficit ROM (p=.65) Confusing section on statistical methods – apparently reporting use of Wilcoxon signed ranks tests for inter-group comparisons Authors did not respond to request for data.	No drop outs Exclusions: n=3 from each group (9%) did not complete interventions No management of losses described Co-interventions not explored No ITT analyses. reported
Gonzalez-Inglesias et al (2009) Spain Acute / sub-acute	RCT Two groups: A: Kinesio Taping to the cervical spine (with tension) B: Sham Kinesio Taping (without tension) Recruitment of patients referred by a primary care physician to physiotherapy	Acute injury (within 40 days of injury), QTF II, neck pain and musculoskeletal signs, no evidence of conduction loss on clinical neurological examination, concussion during accident, treatment for neck pain prior to accident, previous whiplash, neck pain, headaches, psychiatric or psychologic condition, another somatic condition (e.g. fibromyalgia), current claim for litigation or compensation. Baseline: 72 hours post recruitment, within 40 days of injury. n=41 patients	***Intervention*** Both groups: No analgesia or anti-inflammatory medication prior to study. Interventions A and B implemented 1 day post baseline. A: Waterproof porous adhesive Kinesio Taping, width 5cm, thickness 0.5mm. Standardised therapeutic application to apply tension to the posterior cervical structures. Taping applied in positions of LSF, RSF and flex. B: Kinesio Taping similarly to group A but under no tension with neck positioned in neutral. ***Setting:***	***Short term*** Neck pain: NPRS CROM goniometric evaluation of flexion, extension, left side flexion, right side flexion, left rotation and right rotation, measured in degrees. ***Assessments:*** Short term: Immediately after taping 24 hours post intervention (unclear in article)	Group A statistically significant greater decrease in mean neck pain at immediate (p<.001) and 24 hour (p<.001) follow-ups. Group A statistically significant greater improvement in all ranges of movement at immediate and 24 hour follow-	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation No loss to follow up Co-interventions not explored No ITT analyses reported

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
		A: n=21 10 male, 11 female Age: mean 33 years (SD =6) Mean(SD) days post accident: 22 (SD=9) B: n=20 10 male, 10 female Age: mean 32 years (SD 7) Mean(SD) days post accident: 24 (SD 8)	Unclear		ups (p<.001 in all tests). Authors no longer possess data.	
Jull et al (2007) Australia Chronic	RCT Two groups: A: Multimodal physiotherapy programme B: Self-management programme Recruitment by referral from General Practitioner or general advert in popular press. Stratification for presence or not of widespread mechanical or cold hyperalgesia.	Chronic whiplash resulting from road traffic accident, WADII, aged 18-65, persistent problems 3 months to 2 years post injury, and no WADIII, WADIV, previous neck pain, previous road traffic accident, not fluent in English, or currently receiving physical therapy. Baseline: n=71. 3 months – 2 years post injury. A: n=36, 63% female Age: mean 41 years (SD 12) Months since injury: mean 13.3 (SD 6.0) B: n=35, 80.6% female Age : mean 38 years (SD 10) Months since injury: mean 12.0 (SD 7.4)	A: Multimodal programme delivered by a physiotherapist. Intervention of 10 weeks and 10-15 treatments, respecting chronicity. Low load to avoid provocation. Included exercises to: re-educate muscle control of the neck and scapular, posture, functional activities, retraining kinaesthetic sense. Included low velocity mobilisation techniques, education and assurance, advice to continue exercise at home. B: Information about whiplash and advice to stay active and exercise documented in a booklet, that included: education about the mechanism of WAD, assurance re recovery, advice to stay active, ergonomic advice re ADL, advice re an exercise programme. The advice and exercise programme were similar to that provided to group A. Encouraged to perform exercises twice per day. **Setting:** Unclear	***Short term:*** Neck pain and disability: NPI (primary outcome). ROM cervical spine: 3D Fastrac device. Cervical muscle test: CCFT Psychological tests: GHQ-28 IES TAMPA Participants perceptions: Benefit of treatment VAS Gaining of relief VAS ***Assessment:*** Short term immediately post treatment.	Significantly greater reduction mean NPI in group A (p=.04); greater improvement in mean muscle function CCFT in group A (p<.018), but, significantly lower mean change on TSK in group A (p=.02). No significant differences between groups in mean ROM gain (all p>.35), mean change on GHQ-28 (p=.28), or mean change on IES p=.15). Authors provided data.	Primary outcome measure specified Primary endpoint specified *A priori* power calculation conducted on NPI (alpha =.05; power = 90%) Loss to follow up: Drop outs: 2/35 lost to follow up in group B No exclusions No management of losses described ITT analyses performed
Sterling et al	RCT	Chronic WADII. Aged 18-65	A: Three sets of one-minute cervical lateral	***Short term:***	Significantly	*A priori* specification of primary

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
(2010) Australia Chronic	Two groups: A: Cervical spine manual therapy technique (lateral glide). B: Manual contact control intervention. Recruitment by general advertisement and from a University Clinic database.	years, reporting neck pain from a road traffic accident >3months previously, with no WADIII, WADIV, or unable to speak and write English. Baseline: n=39 participants. > 3 months post injury A: n=22. 14 females. Age years: mean 41 (SD 14) B: n=17. 13 females. Age years: mean 39.1 (SD 13.2)	glide spine manual therapy away from the nominated side of pain, with a one minute rest between sets. Patient positioned in supine and treatment at C5-6 level. Pain free technique. B: Hand placement and positioning as for group A, but with no neck movement. Pain free for the participant. Setting: Unclear	PPT: hand held algometer (Somedic), evaluations at cervical spine, median nerve, and Tibialis Anterior sites. TPT: Thermotest system evaluating hot and cold pain thresholds at C5-6 spinous processes. NFR threshold and VAS pain measured at right sural nerve. *Assessment:* Short term immediately post treatment.	greater increase in mean NFR threshold in group A (p=.04). No significant difference between interventions for NFR pain rating (p=.063), PPT cervical spine (p=.78), PPT median nerve (p=.068), PPT Tibialis Anterior (p=.49), and TPT heat (p=.55) or cold (p=.48). Data not requested from authors as no comparable outcomes to other trials.	outcome measure assumed owing to power calculation Primary endpoint specified *A priori* power calculation conducted on NFR threshold (alpha = .05; power = 80%) No loss to follow up for sensory measures. Loss to follow up for NFR: A: n=3 (14%) B: n=2 (12%) NFR could not be elicited. No management of losses for NFR described No ITT analysis reported
Physiotherapy management Whiplash Associated Disorder (WAD) I/II						
Ask et al (2009) Norway Sub acute	RCT Two groups: A: Motor control exercises. B: Endurance and strength training exercises Recruitment by consecutive	Sub-acute (> 6 weeks and < 3 months) whiplash injury from car collision, symptoms within 48 hours of injury, WADI or WAD II, NDI ≥10, aged 18-67 years with no cervical fracture or dislocation, neurological deficit, head injury or concussion related to the injury, serious mental disease, inflammatory rheumatic disease, prior cervical surgery, alcohol or drug abuse,	***Intervention:*** Both groups: to maintain usual activities and avoid using a soft collar. Both interventions 1:1 physiotherapy, with 1-2 sessions per week, over 6 weeks, with a minimum of 6 & maximum of 10 sessions. Each session lasted approximately 30 minutes. Both groups encouraged to perform daily home exercises and to participate in common activities. Exercise programmes were adjusted if pain were exacerbated during the intervention	***Short term:*** ***Primary outcome:*** NDI (0-50). ***Secondary outcomes:*** VAS Pain (100mm) morning and evening. Pain drawing (1-120). Passive flexibility as part of the	No statistically significant difference between groups for any outcome. On NDI (primary outcome): p=.912 at short -term and p=.783 at long-term assessments. Authors did not	Primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: (same at 6 weeks and 1 year): A: n=2 (1 other illness) B: n=3 (no time for treatment)

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	recruitment from Emergency department. After 4 weeks patients contacted to see if symptoms were persisting and if so, to invite to baseline assessment.	pregnancy, or insufficient knowledge of Norwegian language. WADII: No separation of data for WADI and WADII. Baseline (6 weeks post injury): n=25 Stratification: for age and gender. Group A: n=11 Group B: n=14	period. A: Motor control exercises. Motor relearning programme. Initial focus on coordination/holding neck flexor/extensor and shoulder girdle muscles, at low load and pain free x 10 reps; using pressure biofeedback. Mean of 8.0 treatments. B: Endurance and strength training exercises. 5 minute warm up. Higher load to recruit deep and superficial flexor and extensor muscles, using rubber band; upper body strengthening; 15-20 reps with no discomfort. 5 minute stretching. Mean of 8.4 treatments. ***Setting:*** Outpatient spine clinic.	GPE-52 (scale 0-9.2): shoulder retraction, lumbo-sacral, head nod, head rotation. Number of tender points (max 18). Isometric endurance neck flexors and extensors. CROM (Myrin goniometer / compass) flex/ext, rotation, side flexion. ***Long term:*** As short term; plus: PGIC (7 point scale) Satisfaction with care (5 point scale) Co-interventions Work status ***Assessments:*** Short term at 6 weeks after start of intervention (12 weeks post injury). Long term at 1 year post randomisation (58 weeks post injury).	respond to request for data.	No exclusions Management of losses: Missing data imputed - median or mean group difference from baseline to 6 weeks and from baseline to 58 weeks. Co-interventions not explored ITT analyses performed Per protocol analyses also performed.
Bonk et al (2000) Germany	RCT 2 groups: A: Active therapy.	Acute WAD I or II, aged 16-60 years with no: prior neurological disease, prior neck injury, x-rays showing old fractures or skeletal	Both groups could use analgesics, anti-inflammatories A: No collar. Active therapy with	***Short term:*** Neck pain prevalence (%) Neck stiffness prevalence (%)	No statistically significant differences between groups on any outcome	No primary outcome measure specified No primary endpoint specified

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
Acute	B: Collar therapy. Control group of healthy subjects to assess background prevalence of symptoms. n=25 female and 25 male. Mean age 25.8(5.8) years. Recruitment of consecutive rear end collisions presenting to emergency department.	malformations, spondyloarthropathy, symptom onset > 3 days post injury, WADIII or WADIV. WADII: No separation of data for WADI and WADII. Baseline: Within 3 days of injury. A: n=53 n=47 analysed. 19 female, 28 male age mean 26.7 (SD 7.7) years B: n=50 26 female, 24 male age mean 28.7 (SD 9.1) years	physiotherapist. 3 sessions in week 1, 2 sessions in weeks 2 and 3. Ice to neck muscles for 10 minutes, passive mobilisation of neck in supine, active mobilisation neck , strengthening and isometric exercises. Supine week 1, sitting week 2. Week 3 – interscapular muscle strengthening exercises, advice re posture. B: Collar therapy. Wearing a collar for 3 weeks during day. No physiotherapy, activity, exercises or mobilisation. ***Setting:*** Unclear	Headache prevalence (%) Shoulder pain prevalence (%) Arm pain prevalence (%) Neck ROM flex/ext cm Neck ROM side flexion goniometer (degrees). Neck ROM rotation goniometer (degrees). ***Assessments:*** Short term: Reported at 6 weeks Reported at 12 weeks	at 6 or 12 weeks follow-up. Authors did not respond to request for data.	No *a priori* power calculation Loss to follow up: No drop outs Exclusions: A: 1 developed neurological symptoms, n=5 non-compliant with therapy (11%). n=47 analysed. No management of losses described Co-interventions not explored No ITT analyses reported
Pato et al (2010) Switzerland Chronic WAD	RCT 3 groups: A: Local anaesthetic infiltration. B: Physiotherapy. C: Medication. Followed by randomization to CBT or no CBT in each group (1:1). Recruitment of	WADI or II, due to hyperflexion or hyperextension injury, symptoms > 6 months, < 12 months post injury, with no fracture / dislocation, injuries to other areas of the body from the accident, head trauma, loss of consciousness, post traumatic amnesia, head injury, previous brain injury, previous neurological deficit, previous whiplash, pre-existing neck pain, or previous neck surgery. WADII: No separation of data for	8 week treatment period A: Local anaesthetic infiltration tender points (evoked by palpation / movement) in neck. No injection given in a session if no painful or tend point found. Up to 16 sessions per patient. B: Massage, learned relaxation techniques of myogelotic muscles, programme of isometric and low intensity isotonic training neck muscles, continued as home exercises. 2 sessions per week. C: 200mg flurbiprophen (slow release) once per session. Patients seen twice a week by study physician.	**Primary outcome measures:** Subjective outcome rating (4 categories: worse/ unchanged / improved /resolved) Pain McGill Pain VAS (0-10 scale). Working capacity (% determined by physician) Secondary outcome measures: HAQ Well Being Scale (Zerssen)	No statistically significant difference in efficacy between the 3 interventions. CBT had a significant effect but only in women, for pain. Results reported for n values of: A: 27 B: 23 C: 23 No CBT: 33 CBT: 40. Authors did not	*A priori* specification of primary outcome measure assumed owing to power calculation No primary endpoint specified *A priori* power calculation conducted on pain intensity (alpha = 0.05; power 0.8; effect size 0.6). Loss to follow up: Drop outs: Losses of 16% reported. A: n=3 discontinued, 2 did not tolerate intervention, 1 on

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	participants identified through Swiss Accident Insurance Fund and Swiss Insurance Association registers. All patients meeting criteria referred to a coordinator. Stratification: Gender, age and education .	WADI and WADII. Baseline: 6-12 months post injury. A: n=30 67% women age mean 38 (SD 11) randomised to: CBT n=16 No CBT n=14 B: n=29 57% women age mean 40(SD 12) randomised to: CBT n=14 No CBT n=15 C: n=28 61% women age mean 43(SD 13) randomised to: CBT n=14 No CBT n=14	CBT: 2 sessions per week by psychologist (16 sessions), 60 mins per session. Followed a therapy manual provided to participants. Aimed to teach control of pain through control of physical reaction to stress and chronic pain management techniques. No CBT: No additional management. Setting: Unclear	CFQ to evaluate cognitive ability **Assessments:** Short term: Immediately after treatment period 3 months later. 6 months later.	respond to request for data.	lawyer's advice (n=27 in analysis, 16 with CBT and 11 without) B: n=6 discontinued, 2 dissatisfied with intervention, 3 study too long, 1 moved away (n=23 in analysis, 13 with CBT and 10 without) C: n=5 discontinued, 3 dissatisfied with intervention, 1 on lawyer's advice, 1 study too long (n=23 in analysis, 11 with CBT and 12 without) No exclusions No management of losses reported Co-interventions not explored No ITT analyses reported
Scholten-Peeters et al (2006) Netherlands Sub-acute	RCT 2 groups: A: GP care B: Physiotherapy Recruitment from 122 GP practices and 3 emergency departments. Eligibility checked at 2 weeks post injury.	Acute WAD I or II as a result of a road traffic accident, with symptoms (neck pain/headache/dizziness) within 48 hours injury, living in Netherlands, aged 18-55, with no: cervical hernia, past cervical spondylodesis, loss of consciousness, history of previous neck or head injury in past 3 years, insufficient knowledge of Dutch language, or co-morbidities. No separation of data for WADI and WADII.	**Both interventions:** Both interventions were delivered according to a dynamic biopsychosocial treatment protocol using treatment goals and corresponding interventions. Patient centred. Treatment commenced 4 weeks post injury. Maximum duration interventions 9 months. No limit to number of sessions. Treatment ended when problem was resolved or treatment goals achieved, or when plateau of improvement reached. A: 10 minute sessions with GP. Education and advice on graded activity, dependent	**Primary outcome measures (short and long term):** Neck pain VAS (0-100) Headache intensity VAS (0-100) Work activities in daily living VAS (0-100) ***Secondary outcome measures:*** Functional recovery VAS General Health Status SF36 (0-100)	No statistically significant difference between groups for primary outcomes of neck pain or headache intensity at 12 or 52 weeks, or work activities at 12 weeks (adjusted and unadjusted for baseline characteristics).	Trial protocol published with *a priori* specification *A priori* specification of primary outcome measures assumed owing to power calculation No primary endpoint specified *A priori* power calculation conducted on pain and work activities VAS (alpha = 0.05; power 0.8; difference of 20%). Loss to follow up:

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	Stratification for: general practice / emergency department, region of Netherlands (middle/south).	Baseline: 4 weeks post injury. A: n=42 Mean age (SD) 33.8(10.3) 61.9% women B: n=38 Mean age (SD) 31.9(9.0) 71.1% women *Note:* *High initial pain intensity and work disability compared to other studies.*	upon treatment goals. Reassurance, remain active, and resume activity as soon as possible, and expected prognosis. Emphasis that withdrawal from activity, soft collar use and reliance on medication may delay recovery. Decreased focus on pain and encouraged patient to take responsibility. Mean no of treatment sessions 3.9(2.9), mean treatment episode at 18.8(15.2) weeks. B: 30 minute sessions with physiotherapist. Education, advice, graded activity, as for GP. Graded activities with supervision, motivation, reassurance. Exercise – progressive loading cervical and shoulder muscles, active movements, posture and balance. Function – carrying, lifting, pushing and cycling using graded progression. Manual techniques as indicated, but not first choice of treatment. Mean no of treatment sessions 12.7(12.1), mean treatment episode at 19.9(13.5) weeks. Setting: Unclear	ROM cervical spine (degrees): flex/ext, side flexion, rotation, total ROM. Fear of movement Tampa (17-68) Coping PCI Disability NDI (0-50) Disability in housekeeping and social activities VAS (0-100) ***Assessments:*** Short term: 8 weeks post injury. 12 weeks post injury. 26 weeks post injury Long term: 52 weeks post injury. 52 week follow up by questionnaire only.	Group A significantly better than B for work activities (unadjusted for baseline characteristics) at 52 weeks. Some statistically significant differences on secondary outcomes but inconsistent across unadjusted and adjusted analyses Authors did not respond to request for data.	Drop outs: At 12 weeks (4%): A: n=1 loss of motivation, n=1 recovered B: n=1 not satisfied with treatment Loss to follow up greater for secondary outcome measures. No exclusions Management of losses: Missing values imputed using group means/medians Co-interventions: Received co-interventions at 12 weeks (7%): A: n=6 B: n=0 Received co-interventions at 52 weeks (15%): A: n=12 B: n=4 ITT analyses performed Per protocol analyses also performed
Stewart et al (2007) [Stewart et al (2003)] Australia Chronic	RCT 2 groups A: Exercise and advice B: Advice alone Recruitment by	Patients presenting for medical care of WAD I-III within one month of injury, reporting at least mild disability, score at least 20% on pain or disability primary outcome measure; with no: previous neck surgery, known or suspected serious pathology, nerve root	Both groups received advice based on the baseline assessment prior to randomisation. A: 6 week graded exercise programme under supervision by physiotherapist (12 sessions), including 1 hour exercise – 30 mins supervised by physiotherapist. Individualised, progressive, sub-maximal programme designed to enable	***Primary outcome measures*** Pain intensity VAS (0-10) over previous 24 hours. Pain bothersomeness VAS (0-10) over previous 24 hours. Functional ability using PSFS (0-10).	Statistically significant improvement in mean pain (p=.005), bothersomeness (p=.019) and PSFS (p=.006) in group A at 6 weeks. No	No primary outcome measure specified (multiple measures specified) No primary endpoint specified *A priori* power calculation conducted on VAS pain intensity and pain bothersomeness and NDI (alpha = 0.05; power 80%)

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	letters to claimants who experienced a whiplash injury 3-12 months earlier	compromise (WAD III), contraindication to exercise, severe depressive symptoms (DASS), neck radiograph since accident, current physiotherapy treatment, poor use of English. No separation data WAD I II or III. Authors confirmed only WAD I and II participants. Baseline: 3-12 months post injury. N=134 randomised. A: n=66 Age (years) mean (SD) 43.9 (15.1) Gender female n (%) 48 (73%) B: n=68 Age (years) mean (SD) 42.7 (14.4) Gender female n (%) 41 (62%)	completion of functional activities specified by the participant as difficult owing to whiplash, including: aerobic exercise, stretches, functional activities, focus to build speed, endurance and coordination, trunk and limb strengthening exercises, principles of CBT, goal setting, self monitoring of progress, self reinforcement, encouragement to continue as home programme. Mean number of sessions 9.9 (range 0-12). B: Standardised education, reassurance and encouragement for resuming light activity alone, emphasis on positive prognosis, addressing common inaccurate beliefs re whiplash, physical activity positive to recovery, excessive voluntary limitation of activity being problematic, checking understanding and beliefs of whiplash; including written summary of main points. One consultation and two follow-up phone calls (2 and 4 weeks) by physiotherapist. Mean number of sessions 2.9 (range 1-3). ***Setting:*** Two physiotherapy clinics	***Secondary outcome measures*** Disability using NDI (0-50). GPE 11 point scale (-5 to 5) Health related quality of life using physical and mental summary scores of SF36. Work status Adverse effects of treatment using open questions. Perception of credibility of intervention using a questionnaire at 6 weeks only. Compliance with activity programme using exercise diaries and attendance register at 6 weeks only. ***Assessments:*** Short term: 6 weeks post baseline (not explicitly stated) Long term: 12 months	statistically significant differences at 12 months. Statistically significant improvement in mean NDI (p=.004), SF36 physical (p=.003), SF36 Mental (p=.005) and GPE (p=.006) in group A at 6 weeks. No statistically significant differences at 12 months. Authors provided data.	with no adjustment for alpha spend Loss to follow up: Drop outs: A: total losses 3 (4.5%) B: total losses 6 (8.8%) A: No loss to follow up at 6 weeks B: 2 lost to follow up at 6 weeks A: 3 lost to follow up at 12 months B: 4 further lost to follow up at 12 months Management of losses: Missing data were imputed using appropriate mean item score (for that participant) Participants were omitted from analyses if all follow up data were missing. Co-interventions: Co-interventions by 6 weeks: A: n=10 (15%) B: n=15 (23%). Co-interventions by 12 months: A: n=18 (29%) B: n=35 (56%) ITT analyses performed
Thuile and Walzl (2002)	RCT 2 groups:	Kramer whiplash grades I and II, with pain (neck pain, post head pain, shoulder / arm	A: Standard medication with diclofenac and tizanidine. With magnetic field system 'Vitalife MRS 2000' at intensity 50%	Pain VAS (0-10) for head, neck and shoulder/arm areas.	Statistically significant lower pain in head,	No primary outcome measure specified

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
Austria Acute (? Unclear)	A: Standard medication with magnetic therapy. B: Standard medication. Recruitment of patients reporting for treatment.	pain, stiffness neck), loss of mobility in three directions. WADII: No separation of data for WADI and WADII. Baseline: Unclear A: n=44 21 men, 23 women Mean (SD) age 37.2(17.8) B: n=48 31 men, 17 women Mean (SD) age 44.8(22.6)	(10,000 nano Tesla) for first 2 days, then 100% (20,000 nano Tesla) for two subsequent days, then 150% (30,000 nano Tesla) for a further 10 days. MRS cushion for 16 minutes and whole body mat for 8 minutes. Polarity switched every 2 minutes. B: Control of standard medication with diclofenac and tizanidine. ***Setting:*** Clinic for neurology and psychiatry, although not explicitly stated.	ROM in three planes (degrees): Flex/ext Rotation Side flexion No detail of measurement tool. ***Assessments:*** Short term – unclear	neck and shoulder/arm for A (p<.003). Statistically significant higher ROM in all three planes for A (p<.05). Authors did not respond to request for data.	No primary endpoint specified No *a priori* power calculation Loss to follow up: No data reported on loss to follow up No management of losses described. Co-interventions not explored No ITT analyses reported
Vassiliou et al (2006) Germany Acute	RCT 2 groups: A: Physical therapy B: Standard treatment Recruitment by presentation to trauma department one hospital within 48 hours of injury.	WAD I and II, within 48 hours of injury, aged 18-70 years, with no: history of chronic or recurrent pain within previous 6 months, additional accident related injury, diseases or contraindications to treatment procedures, living > 50km away, pregnant, or further accident / surgery head, neck or thorax during trial, patients treatment by physiotherapists other than those in the trial, patients with modified treatments due to new findings and diagnoses. WADII: No separation of data for WADI and WADII. Baseline: Within 48 hours of	A: Physical therapy 10 sessions within the first 14 days post injury. Heat to neck for 5 minutes, lymph drainage for 10 minutes, massage for 10 minutes, active exercises with elastic resistance to neck and shoulder for 10 minutes. Home exercises for 20 minutes each day. In addition to medication (diclofenac and ranitidine). Use of soft collar allowed as demanded by patient for first 2 days post injury. B: Standard treatment of soft collar continuously worn for first 7 days in addition to medication (diclofenac and ranitidine). Then no specific treatment. ***Setting:*** Unclear	***Primary outcomes*** Pain intensity NRS (0-10) Disability intensity NRS (0-10) ***Secondary outcomes*** Days with oral medication. Period of immobilisation with soft collar. Localisation of injury-associated pain disorder (marked on a dermatomal map) Resolution of pain. ***Assessments:*** Short term:	Statistically significant lower pain (p=.002) and disability (p=.002) for group A at 6 weeks, and at 6 months (p<.001 for pain and for disability). Used 1 tailed test for primary outcomes. Authors did not respond to request for data.	Primary outcome measures specified No primary endpoint specified *A priori* power calculation conducted on pain intensity and disability (alpha 0.05; power 0.9; anticipated 30% benefit) Loss to follow up: Drop outs: 1 week post baseline: A: n=7 B: n=14 6 weeks post baseline: A: n=15 (15%) B: n=35 (36%) 6 months post baseline: A: n=31 (30%) B: n=45 (46%) No exclusions Management of losses:

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
		injury. Mean time interval between injury and enrolment 8.5(9.3) hours. A: n=103 Age mean(SD) 30.1(10.3) 62.1% female B: n = 97 Age mean(SD) 28.3(8.9) 60.8% female		1 week post baseline 6 weeks post baseline 6 months post baseline		Missing values imputed using last value carried forward. Co-interventions not explored ITT analyses performed Per protocol analyses also reported Consistent findings for per protocol analysis
Vikne et al (2007) Norway Chronic	RCT 4 groups: A: Traditional physiotherapy with no home training B: Traditional physiotherapy with home training C: Sling exercise therapy with no home training D: Sling exercise therapy with home training Recruitment through insurance company. All patients with ongoing claims.	Patients aged 18-60 who have experienced a traffic accident 6-12 months previously, WADI or II, with no: ongoing treatment, pregnancy, alcohol or drug abuse, serious illness, language difficulties. WADII: No separation of data for WADI and WADII. Baseline: 6-12 months post injury. 43.9% scored as 'psychiatric cases' on the HSCL. A: n=53 B: n=55 C: n= 51 D: n= 54	Home programmes started after 3 weeks in all groups. A: Traditional physiotherapy with usual exercises focused to strength and endurance training of the neck, back and abdominal muscles. Using patient's body weight as resistance, patient manuals, and fixed training devices. Passive modalities including electrotherapy, massage, manipulation and acupuncture as required but emphasis on active treatment. Training stopped at 4 months. Contacted by physiotherapist by telephone and encouraged to train every fourth month for 12 months. Plus home training programme based on exercises covered in traditional physiotherapy sessions. B: As above but home training programme continued to 12 months, and changed once a month. C: Protocol of 10 graded exercises using ceiling mounted sling with patient sitting and supine to mobilise and strengthen. Combined with traditional physiotherapy intervention. 24 sessions over 4 months.	Complaints on a scale (1-9) Pain neck/shoulder past 14 days VAS Modified RMDQ Sick leave Psychological distress using Hopkins Symptom Checklist (HSCL) 25 item reporting previous week. Cervical ROM: Flexion, extension, left rotation, right rotation in degrees. Neck stabilisation/endurance hold in seconds. Cervico kinaesthetic sensibility – relocation from rotation. ***Assessments:*** Short term: 4 months post baseline	No statistically significant differences between groups (p=.07 to .82) except for small effect for home training on pain during rest (p=.05) and reported fatigue (p=.02). Pooling AB v CD small effect (p=.01) on neck endurance for AB. Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: At 4 and 12 months (1 drop out prior to intervention): A: n=6, n=5(21%) B: n=5, n=5 (18%) C: n=6, n=5 (22%) D: n=4, n=6 (19%) (Some reasons provided. 1/3 not related to treatment) 20% drop outs overall (10% at 4 months) Exclusions: N=6 excluded owing to incomplete adherence, and unclear whether exclusions are included as part of drop out figures.

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
			Training stopped at 4 months. Contacted by physiotherapist by telephone and encouraged to train every fourth month for 12 months. Plus home training programme using ceiling mounted sling at home. D: As above but home training programme continued to 12 months, and changed once a month. ***Setting:*** Institute	Long term: 12 months post baseline		No management of losses described Co-interventions not explored No ITT analyses reported
Physiotherapy management Whiplash Associated Disorder (WAD) II/III						
Armstrong et al (2005) New Zealand Chronic *Study involved two cohorts of whiplash and healthy control patients. Whiplash only cohort reported here. Design not followed through to make any comparisons on outcomes for A and B.*	RCT 4 groups: A: Cranio-cervical stability exercises B: Control Recruitment by local newspaper advertisement	Patients with minimum of 1 whiplash injury, > 3 months previously, < 5 years previously, WAD II/III; with no therapy at time of study, previous history of head injury, spinal fracture/dislocation, spinal surgery, systemic inflammatory disorders, neurological disorders, Meniere's Disease, disabling vertigo, medication for vertigo, inner ear damage, large metallic implants. No separation data for WAD II and III. A: n=? unclear B: n=? unclear	A: Cranio-cervical action in sitting as a stabilizing exercise of the cervical spine, combined with scapular stabilising. 4/5 practices with simultaneous performance of head and neck joint position tasks, with and without a blindfold. B: Rest in a lightened room for 15 reading a magazine. ***Setting:*** Unclear	Head and neck position sense (Fastrak) ***Assessments:*** Short term: Immediately post treatment	Design not followed through to make any comparisons on outcomes for A and B. No statistical tests reported on whiplash participants only. Authors did not respond to request for data.	No primary outcome measure specified Primary endpoint specified No *a priori* power calculation No reporting of loss to follow up No management of losses described No comparative analysis reported No ITT analyses reported
Fernandez-	RCT	Participants with a history of	Both groups – conventional physiotherapy	VAS (1-100mm) neck pain, dorsal	Statistically	No primary outcome measure

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
de-las-Penas et al (2004a) Spain Acute / subacute Study involved two cohorts of whiplash and mechanical neck pain patients. Whiplash only cohort reported	2 groups: A: Dorsal manipulation technique and conventional physiotherapy treatment. B: Control of conventional physiotherapy treatment. Recruitment through a private clinic for physical therapy and osteopathy. N=88 volunteers from and initial sample of n=120 were recruited.	whiplash injury WAD II / III, for 3 weeks to 3 months; with no prior whiplash injury, articular instability (fracture, luxation), degenerative cervical alteration. No separation data for WAD II and III. A: n=44 B: n=44	treatment – consisting of active exercises at home, electrotherapy, ultrasound therapy, muscle stretching, multimodal therapy, and manual therapy. 15 sessions of treatment. A: Dorsal manipulation at 5th and 10th treatment sessions. HVLA 'Dog' technique. Single technique with cavitation, and conventional physiotherapy. B: Conventional physiotherapy treatment only. **Setting:** Private clinic for physical therapy and osteopathy, although not explicitly stated.	region pain, and head pain. ***Assessments:*** Short term: After 10 treatment sessions (one week after dorsal manipulation at 5th treatment session). After 15 treatment sessions) one week after dorsal manipulation at 10th treatment session).	significant mean reduction in neck pain for group A (p=.002) after 15 treatment sessions. Statistically significant mean reduction in dorsal pain for group A after 10 (p=.001) and 15 (p=.001) treatment sessions. No statistically significant change in mean head pain (p>.20) Authors no longer possess data.	specified No primary endpoint specified No *a priori* power calculation Loss to follow up: No apparent losses but not explicitly reported. Co-interventions not explored No ITT analyses reported
Fernandez-de-las-Penas (2004b) Spain Acute	RCT 2 groups A: Manipulative protocol. B: Control of conventional physiotherapy Recruitment from a private clinic for manual therapy	Acute whiplash injury < 3 months duration, WAD II / III, for < 3 months; with no prior whiplash injury, previous cervical surgery, having manipulative or manual therapy within past month, or articular instability (fracture, luxation). Baseline: A: n=190 Females n=50	A: Manipulative protocol including high velocity low amplitude techniques, soft tissue mobilisation techniques and mobilisation techniques. Weekly manipulative treatment. Mean of 9 (SD 1.5) sessions. B: Conventional physiotherapy treatment – consisting of active exercises at home, electrotherapy, ultrasound therapy, muscle stretching, multimodal therapy, and manual therapy. 15 sessions of treatment. Daily physiotherapy treatments. Mean of 23 (SD 3.2) sessions.	VAS head and neck pain (0-100mm). Cervical active range of movement (CROM) flexion and rotation using a goniometer. Number of sessions needed to complete treatments ***Assessments:*** Short term:	No comparison of outcome measures at same time interval post baseline. Comparison for whole treatment packages A and B possible at end of treatment. No results	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: No apparent losses but not explicitly reported. Co-interventions not explored No ITT analyses reported

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	and physiotherapy	Age mean (SD) 27 (7) WAD II n=155 WAD III n=35 B: n=190 Females n= 30 Age mean (SD) 28 (7) WAD II n=150 WAD III n=40	***Setting:*** Private clinic for manual therapy and physiotherapy, although not explicitly stated.	A: after each 4 sessions (i.e. monthly). B: after each 10 sessions (i.e. 2 weeks). Apparent assessment at end of treatment reported in Tables and Figures.	reported for comparison of whole treatment packages, except for number of sessions to complete treatment that was significantly lower for A (p=.002). Authors no longer possess data.	
Hansson et al (2006) Sweden Chronic	RCT 2 groups A: Vestibular rehabilitation programme. B: Control, no intervention. Recruitment from general practitioners and physiotherapists in primary healthcare, orthopaedic physicians in private practice, administrators of rehabilitation at a regional social insurance office, and an	Patients with WAD with reported dizziness. WAD II / III. Baseline: Median 1year post injury (6 months to 15 years) A: n=16 n=16 WAD II, n= 0 WAD III Duration dizziness median (range): 2(0-8) Females n= 10 Age: median 40 (range 22-73) years B: n=13 n=12 WAD II, n= 1 WAD III Duration dizziness median (range): 2(0-15) Females n= 10 Age: median 43 (range 23-76)	A: Vestibular rehabilitation programme of group sessions. 50 minutes twice a week for 6 weeks. Consisting of 10 minute warm up, exercises to stimulate vestibular system using eye, head and trunk movements, progressing to closed eyes. B: Control. No intervention. **Setting:** Physiotherapy centre	4 balance measures 1] Tandem standing with eyes open then closed for 30 seconds each; mean of both legs (seconds). 2] SOLEO: standing on one leg, eyes open (SOLEC closed eyes); mean of both legs (seconds). 3] Walking in a Figure of 8 with steps outside of the figure counted (steps). 4] Walking line. Walking heel to toe on a 5m line, with steps outside the line counted (steps). 5) DHI: 3 dimensions: functional, emotional and physical. ***Assessments:*** Short term:	Statistically significant higher median SOLEO for group A at 6 weeks (p=.02) and 3 months (p<.0005). Statistically significant longer median tandem standing (closed) for group A at 6 weeks (p=.045). Statistically significant lower median DHI for group A at 6 weeks on total (p=.047), functional (p=.005) and physical (p=.033); and at 3 months	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: 11 drop outs (38.0%) (3 other sickness, 3 lack of time, 1 could not tolerate treatment, 4 reason unknown) A: n=8 B: n=3 No exclusions Management of losses: Last observation carried forward. Co-interventions not explored ITT analyses performed

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	orthopaedic hospital clinic.			6 weeks post baseline 3 months post baseline	on physical (p=.04). Data not requested from authors as no comparable outcomes to other trials.	Per-protocol analyses also performed
Physiotherapy management Whiplash Associated Disorder (WAD) 0/I/II						
Rosenfeld et al (2003) Rosenfeld et al (2006) (reporting same trial) Sweden Acute	RCT 4 groups: A: Active intervention within 96 hours injury. B: Standard intervention within 96 hours injury C: Active intervention 14 days post injury D: Standard intervention 14 days post injury. Recruitment of consecutive patients assessed in 29 primary care units, 3 emergency wards and several private clinics.	Individuals exposed to whiplash trauma in motor vehicle collisions, seeking healthcare. Trauma caused by rapid movement of the head resulting in acceleration forces. WAD 0 I or II, with no: neurological deficit WADIII or fracture / dislocation WADIV, head injury, previous symptomatic chronic neck problem, alcohol abuse, dementia, serious mental disease, or diseases that could lead to death before study completion. WADII: No separation of data for WAD 0, I and II. Of the n=97/102 who received allocated intervention, n=4 were classified as WADO at baseline. Baseline: Within 96 hour of injury.	No intervention during delay period for groups C and D. A and C: Active intervention – active exercise protocol of early and repeated movements consistent with McKenzie principles. Two phases 1] information, postural control, cervical rotation exercises, home exercises, exercises within limits of pain, in sitting if tolerated; 2] if symptoms unresolved 20 days post injury, evaluation and treatment according to McKenzie principles. Treatment for 6 weeks unless symptoms resolved earlier. Mean number of treatments 3.95. B and D: Standard intervention – written information on injury, advice re activity, postural correction. Rest in first weeks with soft collar for comfort and limiting excessive movements. Active movement 2/3 times per day a “few weeks” after injury. **Setting:** Unclear	***Short term:*** Pain VAS: combined head, neck, shoulder region CROM lateral flexion (degrees) C ROM rotation (degrees) CROM flexion/extension (degrees) Duration sick leave in previous 6 moths Any additional interventions received. ***Long term:*** As above but with no evaluation of additional interventions. ***Assessments:*** Short term at 6months. Long term at 3 years.	Statistically significant greater reduction on pain intensity in groups A and C at 6 months (p=.0004) and 3 years follow-up (p=.020). Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: 21% overall 8% at 6 month follow up: A: 1 refused participation B: n=3 refused participation C: n=1 not contactable, n=1 moved abroad D: n=1 refused participation, n=1 not needed Further drop outs at 3 year follow up (13%): A: n=1 no time, n=2 not contactable B: n=1 travelling, n=1 not contactable C: n=1 no time, n=1 travelling, n=1 not contactable, n=1 re-injury D: n=1 refused, n=3 not contactable

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
		AT 3 year follow up, subjects matched to a comparison group for gender and age. A: n=25 B: n=26 C: n=26 D: n=25 Baseline data for all participants randomised not provided.				Exclusions: 11% participants excluded at 6 months. n=5 patients excluded post randomisation A: n=3 (not meet inclusion(2), re-injury(1)) B: n=0 C: n=2 (not meet inclusion) D: n=1 (not meet inclusion) Further participants excluded at 3 years (8%): A: n=3 (not meeting inclusion(2),re-injury(1)) B: n=0 C: n=2 (not meeting inclusion) D: n=3 (not meeting inclusion(1) re-injury(2)) Exclusions 19% overall. No management of losses described Co-interventions: Numbers of participants receiving interventions outside of study within 6 months: A: n=3 B: n=9 C: n=5 D: n=9 ITT analyses performed
Schnabel et al (2004) Germany Acute	RCT 2 groups: A: Collar B: Physiotherapy Recruitment of	Motor vehicle accident causing at least one of pain, stiffness or numbness in spine, head or limbs, within 48 hours of injury, ≥ 18 years old, with no: WADIII or IV, loss of consciousness, fracture, or pregnant.	Both groups: Diclofenac 50mg 3 x daily. Requested to not undertake other therapies. A: Collar for 1 week day and night, no advice re sleeping, posture. B:	***Short term*** Symptom prevalence: neck pain, headache, shoulder pain, back pain, limb pain, limb paraesthesia, visual disturbance, tinnitus, dizziness. Average total pain VAS (0-10)	Group B had statistically significant lower prevalence of neck pain(p= .025), headache (p=.028), shoulder pain (p=.008), and	No primary outcome measure specified Primary endpoint specified *A priori* power calculation conducted on unknown outcome measure (alpha 0.05; power 0.9; on 30% benefit)

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	consecutive patients presenting to trauma department	WADII: No separation of data for WADI and WADII. Baseline: 48 hours post injury. A: n=97 Mean age(SD) 28(9) 61% female B: n=103 Mean age(SD) 30(10) 62% female	Physiotherapy exercises for mobilisation. 2-5 visits in the first week dependent upon needs. ***Setting:*** Unclear	Degree of disability VAS (0-10) ***Assessments:*** Short term: 6 weeks post baseline	unresolved symptoms (p=.010) Group B had statistically significant lower mean pain (p=.047) and mean disability (p=.042). Authors no longer possess data.	Loss to follow up: Drop outs: A: 36% B: 15%. No exclusions No management of losses described Co-interventions not explored No ITT analyses reported
Physiotherapy management Whiplash Associated Disorder (WAD) I/II/III						
Soderlund et al (2000) Sweden Acute	RCT 2 groups: A: Regular treatment group. B: Additional exercise group Recruitment of all patients visiting emergency department with notable symptoms when visiting the orthopaedic clinic	Acute whiplash injury with report of acceleration-deceleration movement of the head but without direct trauma, WAD I-III. Aged 18-60 years, with good understanding of Swedish; and no previous neck injury. Mean of 20 days post injury. 35 women and 24 men. n=66. 14% (n=8) were WAD I. 83% (n=49) were WAD II. 3% (n=2) were WAD III. A: n=32. B: n=34. Baseline: mean of 20 days post injury.	A: Exercise programme of alternating rest with exercises, keeping the neck warm, walking daily, maintaining an upright posture when sitting, standing and walking, not lifting or carrying heavy objects, and, not to sit with head flexed forward during first few weeks post injury. Patients were instructed to restore normal neck movements as soon as possible including: cervical rotation, flexion shoulders, deep breath with shoulder girdle elevation. All exercises were performed cautiously, within pain limits, at least three times a day. Patients were advised not to use a collar unless needing to travel by car, read, or study for long periods. B: As above, complemented by exercises for improving kinaesthetic sensibility and coordination of neck muscles, three times a day. ***Setting:***	PDI generic and domain specific disability related to chronic pain. Score 0-70. SES completion of daily living despite pain. Score 0-200. CSQ extent of using cognitive or behavioural coping strategies. Cervicocephalic kinaesthetic sensibility, right and left relocation from rotation. VAS pain intensity (0-10). Compliance with exercises using daily exercise diaries. Cervico-thoracic posture using universal goniometer. CROM right and left rotation using goniometer.	No statistically significant differences between groups on any outcome. Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Losses of n=6 (18.7%) group A and n=7 (20.6%) group B. Drop outs: A: n=3 drop outs at 3 month follow up. B: n= 4 drop outs at 3 month follow up. Exclusions: A: n=3 excluded owing to insufficient data at 3 month follow up. B: n= 3 excluded owing to insufficient data at 3 month follow up.

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
			Unclear	***Assessments:*** Short term: 3 months (unclear whether post baseline or intervention) 6 months (unclear whether post baseline or intervention)		No management of losses described Co-interventions not explored No ITT analyses reported
Soderlund and Lindberg (2001) Soderlund and Lindberg (2007) Sweden Chronic	RCT 2 groups: A: Experimental B: Comparison Recruitment from Orthopaedic clinic of patients with significant symptoms presenting to a 3 month follow up appointment	Patients with continuous symptoms 3 months after a whiplash injury with reports of an acceleration – deceleration movement of the head, but without direct head trauma. WAD I – III. Aged 18-60 years, good ability to understand Swedish. No separation data for WAD I II or III. Baseline: after 3 month follow up appointment in clinic. n=33. A: n=16. Female n=9 mean age 38 years B: n=17. Female n=10 mean age 44 years	A: Individualised four phases of treatment 1] learning of basic physical and psychological skills 2] application and 3] generalisation of skills into general everyday activities 4] maintenance of these skills. Using a functional behaviour analysis approach, and treatment goal setting. Aiming to change problem behaviours and recognise the factors that perpetuate muscular dysfunction. Included techniques of relaxation, re-education posture, muscle stabilisation, mobilisation exercises, and re-education of humeroscapular rhythm. B: Individualised exercises to enhance muscular stabilisation of neck, neck and shoulder mobility with stretching and coordination of head movement, and exercise to maintain body posture and arm muscle strength. Exercises carried out at physiotherapy department and at home. Treatment could also include: pain relieving methods of relaxation, TENS, acupuncture, heat etc. Both interventions with a physiotherapist, maximum of 12 treatment sessions. ***Setting:***	PDI generic and domain specific disability related to chronic pain; 0-70. NRS pain intensity (0-10). Cervico-thoracic posture using universal goniometer. CROM degrees using goniometer. Cervicocephalic kinaesthetic sensibility, right and left relocation from rotation . Patient perception of treatment result 4 questions (only at immediate post treatment follow up) Patient perception of treatment result 7 questions (only at 3 month follow-up). ***Assessments:*** Short term: Immediate post treatment	Statistically significant lower patient perception of pain for group A immediately post treatment (p<.05), significantly better patient perceived ability in group A to perform daily activities at 3 months (p<.05); and significantly better long-term compliance in group A to manage / prevent neck pain at 3 months (p<.05) Treatment integrity was measured. Results not reported on CSQ	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: No drop outs Exclusions: B: n=1 did not comply with treatment No management of losses described Co-interventions not explored No ITT analyses reported

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
			A: Patient's home. B: Physiotherapy department gym & home	3 months follow up	and SES to compare patients with high and low self efficacy. Authors did not respond to request for data.	

Footnote: ADL = Activities of Daily Living; CBT = Cognitive Behavioural Therapy; CCFT = Cranio-Cervical Flexion Test; CFQ = Cognitive Failures Questionnaire; CI = Confidence Interval; CROM = Cervical Range of Motion; CSQ = Coping Strategies Questionnaire; ext = extension; DASS = Depression Anxiety Stress Scale; DHI = Dizziness Handicap Inventory; flex = flexion; GHQ-28 = General Health Questionnaire 28; GPE = Global Perceived Effect; HAQ = Health Assessment Questionnaire; IES = Impact of Events Scale; ITT = Intention to Treat; L = left; LR = Left Rotation; LSF = Left Side Flexion; McGill = McGill Pain Questionnaire; NDI = Neck Disability Index; NFR = Nociceptive Flexion Reflex; NPI = Northwick Park Neck Pain Index; NPRS = Numerical Pain Rating Scale (11 point scale); NRS = Numerical Rating Scale; NSAID = Non-Steroidal Anti-inflammatory agent; PCI = Patient Coping Inventory; PDI = Pain Disability Index; PGIC = Patients' Global Impression of Change; PPT = Pressure Pain Threshold; PSFS = Patient Specific Functional Scale; QTF – Quebec Task Force; R = right; RCT = Randomised Controlled Trial; reps = repetitions; ROM = Range of Motion; RR = Right Rotation; RSF =Right Side Flexion; RMDQ = Roland Morris Disability Questionnaire; SD = standard deviation; SES = Self Efficacy Scale; SF-36 = Short Form 36 Health Survey; TPT = Thermal Pain Threshold; TSK = TAMPA Scale of Kinesophobia; TENS = transcutaneous electrical nerve stimulation; VAS = Visual Analogue Scale; WAD = Whiplash Associated Disorders

Table 4: Summary Assessment of the overall risk of bias for each trial

Study (authors, year, country)	Components of risk of bias							Summary risk of bias	Comments high risk components
	1	2	3	4	5a	5b	6		
WAD II									
Aigner et al (2006)	U	U	U	U	U	U	H	**High (1)** Unclear (6)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Dehner et al (2009)	L	L	U	U	U	N/A	H	**High (1)** Unclear (3) Low (2) N/A (1)	One high risk component: 6 Design problematic with comparison to a previous non-randomised group. Assessment ROB excluded previous group. No primary outcome measure specified No primary endpoint specified No ITT reported
Gonzalez-Inglesias et al (2009)	L	L	L	L	U	N/A	H	**High (1)** Unclear (1) Low (4) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Jull et al (2007)	L	L	L	L	U	N/A	L	**Unclear (1)** Low (5) N/A (1)	No high risk components
Sterling et al (2010)	L	U	L	L	U	N/A	H	**High (1)** Unclear (2) Low (3) N/A (1)	One high risk component: 6 No ITT reported
WAD I/II									
Ask et al (2009)	U	L	L	L	U	U	H	**High (1)** Unclear (3) Low (3)	One high risk component: 6 No primary endpoint specified
Bonk et al (2000)	U	U	H	L	U	N/A	H	**High (2)** Unclear (3) Low (1) N/A (1)	Two high risk components: 3, 6 3 Assessors not blinded beyond baseline. 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Pato et al (2010)	U	U	L	L	U	N/A	H	**High (1)** Unclear (3) Low (2) N/A (1)	One high risk component: 6 No primary endpoint specified No ITT reported
Scholten-Peeters et al (2006) [Scholten-Peeters et al (2003) trial protocol]	L	L	L	L	L	L	H	**High (1)** Low (6)	One high risk component: 6 No primary endpoint specified
Stewart et al (2007) [Stewart et al (2003) trial protocol]	L	L	L	L	L	N/A	H	**High (1)** Low (5) N/A (1)	One high risk component: 6 Co-interventions by 6 weeks: A: n=10 (15%) and B: n=15 (23%) reported seeking additional treatment. Co-interventions by 12 months: A: n=18 (29%) and B: n=35 (56%) reported seeking additional treatment. No primary outcome measure specified No primary endpoint specified
Thuile and Walzl (2002)	U	U	U	U	U	N/A	H	**High (1)** Unclear(5) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported Poor reporting, lacking detail across all components
Vassiliou et al (2006)	L	L	L	H	U	N/A	H	**High (2)** Unclear (1) Low (3) N/A (1)	Two high risk component: 4, 6 4: Losses at 6 weeks (6 months): A: 15%(30%) B: 36%(46%) n=12 (6%) participants excluded due to incomplete outcome data. 6: No primary endpoint specified

Vikne et al (2007)	U	L	L	H	U	U	H	**High(2)** Unclear(3) Low (2)	Two high risk components: 4, 6 4: Losses of 20% at 12 months (10% at 4 months) 6: No primary outcome measure specified No primary endpoint specified No ITT reported
WAD II/III									
Armstrong et al (2005)	U	U	U	L	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 Problematic design and data analysis combining groups. No primary outcome measure specified No ITT reported
Fernandez-de-las-Penas (2004a)	L	U	U	U	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported Selection bias as participants were volunteers
Fernandez-de-las-Penas (2004b)	L	U	U	U	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Hansson et al (2000)	L	L	L	H	U	N/A	H	**High (2)** Unclear (1) Low (3) N/A (1)	Two high risk components: 4, 6 4: Drop outs 38%. 6: Differences at baseline on two outcomes No primary outcome measure specified No primary endpoint specified No ITT reported
WAD 0/I/II									
Rosenfeld et al (2003) [Rosenfeld et al (2006) reporting same trial]	U	L	L	H	U	U	H	**High (2)** Unclear (3) Low (2)	Two high risk components: 4, 6 4: High loss to follow up. Drop out at 6 months (and 3 years): 8% (13%). Exclusions at 6 months (and 3 years): 11% (8%). Includes eligibility errors with participants excluded post randomisation for not meeting inclusion criteria. 6: Co-interventions: 25% participants received treatment outside of study by 6 months; nearly 50% by 3 years. No primary outcome measure specified No primary endpoint specified
Schnabel et al (2004)	H	U	U	H	U	N/A	H	**High (3)** Unclear(3) N/A (1)	Three high risk components: 1, 4, 6 1: Inappropriate method of randomisation. 4: Loss to follow up from groups: A: 36% B: 15% 6: No primary outcome measure specified No ITT reported
WAD I/II/III									
Soderlund et al (2000)	U	U	U	L	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Soderlund and Lindberg (2001) [Soderlund and Lindberg (2007) reporting same trial]	U	U	L	L	U	N/A	H	**High (1)** Unclear (3) Low (2) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported

Footnotes: Components of risk of bias **: 1** Sequence generation; **2** Allocation concealment**; 3** Blinding of participants, personnel and outcome assessors; **4** Incomplete outcome data; **5a** Short term selective outcome reporting; **5b** Long term selective outcome reporting; **6** Other potential threats to validity. Levels of risk of bias: H high risk of bias; U unclear risk of bias; L low risk of bias. N/A: Not Applicable, no investigation of long term outcomes

Table 5: Compatible outcomes across included trials: potential meta-analyses

Acute / sub-acute intervention																
Trial: authors, year **WAD category**	**Interventions (Physiotherapy = PT)**	**N**	**Post injury (unless stated)**					**Comparable outcome measures (across> 1 trial)** √ = possible to calculate from data							**Outcomes not comparable to other trials**
			PT commenced	**Duration of intervention**	**Baseline assessment**	**Short term assessment**	**Long term assessment**	**Pain**	**ROM Flex / ext**	**ROM Rot**	**ROM SF**	**Total ROM**	**Disability**	**Work status**	
Aigner et al (2006) WADII	Laser acupuncture (A) v placebo (B)	25 (A) 25 (B)	Within 1/52	3 weeks	Within 4 days	End of RX at 6-8 weeks	8-12 months		Mean/ range ROM (°)	Mean/ range ROM (°)	Mean/ range ROM (°)	√			Duration: condition, neck pain, headaches, dizziness, collar and drug use Recurrence symptoms.
Dehner et al (2009) WADII	Active (A) v passive PT (B) packages	35 (A) 35 (B)	1 week	7 weeks	1 week	1 month		VAS (100mm)				Mean/ range ROM (°)		Days off work	Sickness costs
Gonzalez-Inglesias et al (2009) WADII	Kinesio-taping (A) v sham (B)	21 (A) 20 (B)	≤ 41 days / 6 weeks	24 hours*	Within 40 days	Immed post RX & 24 hours		NPRS 0-10	ROM (°)	ROM (°)	ROM (°)	√			

Ask et al (2009) WADI/II	Motor control training v strength / endurance training	11 (A) 14 (B)	6 weeks	6 weeks	6 weeks	12 weeks	58 weeks	VAS 100 mm	Median (IQR)	Median (IQR)	Median (IQR)	√	NDI (0-50)	Work status	Pain drawing Satisfaction GPE 52 Isometric testing, tender points PGIC.
Bonk et al (2000) WADI/II	Active v collar	53 (A) 50 (B)	3 days	3 weeks	3 days	6 and 12 weeks			Mean (SD)	Mean (SD)	Mean (SD)	√			Prevalence neck pain, stiffness, headache, shoulder pain, and arm pain.
Scholten-Peeters et al (2006) WADI/II	GP v PT	42 (A) 38 (B)	4 weeks	Up to 20 weeks	4 weeks	8, 12 and 26 weeks	52 weeks	VAS 0-100	Mean (SD)	Mean (SD)	Mean (SD)	√	NDI (0-50)		VAS: headache intensity, work activities daily living, functional recovery, disability in house-keeping. SF36 TSK PCI.
Thuile and Walzl (2002) WADI/II	Standard medication & magnetic therapy v standard medication	44 (A) 48 (B)	*	2 weeks	*	*		VAS 0-10	Mean (SD)	Mean (SD)	Mean (SD)	√			
Vassiliou et al (2006) WADI/II	PT v standard care	103 (A) 97 (B)	2 days	2 weeks	2 days	1& 6 weeks, 6 months		NRS 0-10					NRS 0-10		Days oral medication Period of immobilisation Localisation of injury Resolution pain

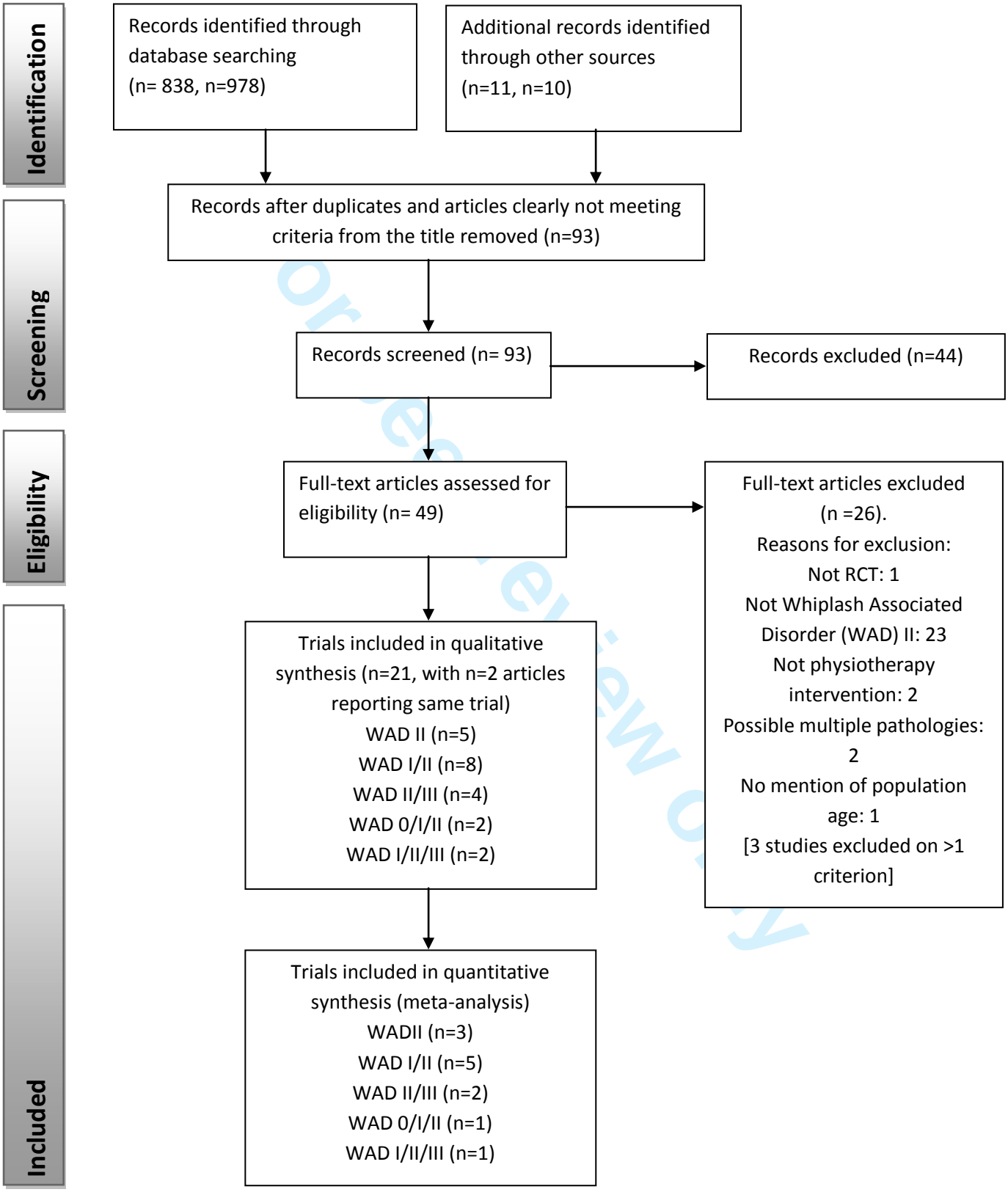
Fernandez et al (2004a) WADII/III	Dorsal manipulation & PT V PT	44 (A) 44 (B)	3 weeks to 3 months	15 sessions	3 weeks to 3 months	1 week after 1st & 2nd 10 sessions		VAS 1-100mm						
Fernandez et al (2004b) WADII/III	Manipulation v control	190 (A) 190 (B)	< 3 months	*	< 3 months	Post completion RX		VAS 0-100mm		Mean (SD) *				ROM flex
Rosenfeld et al (2003, 2006) WAD0/I/II	Active<96hrs v standard<96hrs v active <14 days v standard <14 days	25 (A) 26 (B) 26 (C) 25 (D)	< 96 hrs or <14 days	3-6 weeks	< 96 hrs or <14 days	6 months	3 years	VAS 0-100mm	Mean (SD)	Mean (SD)	Mean (SD)	√		Sick leave	Any additional interventions
Schnabel et al (2004) WAD0/I/II	Collar v PT	97 (A) 103 (B)	48 hours	1 week	48 hours	6 weeks post baseline		VAS 0-10					VAS 0-10		Symptom prevalence in different areas
Soderlund et al 2000 WADI/II/III	Regular + additional excs v regular excs	29 (A) 30 (B)	mean 20 days	*	mean 20 days	3 and 6months		VAS pain (0-10)		Mean (SD)			PDI 0-70		Kinaesthetic sensibility Cervico thoracic posture SES daily living CSQ

Chronic intervention															
Jull et al (2007) WADII	Multimodal PT v self management	36 (A) 35 (B)	3 months – 2 yrs	10 weeks	3 months – 2 yrs	Immed post RX			Change ROM (°)	Change ROM (°)	Change ROM (°)	√			CCFT IES TSK GHQ-28
Sterling et al (2010) WADII	Cervical lateral glide v control	22 A 17 B	>3 months post injury	1 session	>3 months post injury	Immed post RX									PPT TPT NFR
Pato et al (2010) WADI/II	Infiltration v PT v medication	30 (A) 29 (B) 28 (C)	6-12 months	8 weeks	6-12 months	Immed & 3 & 6 moths		VAS 0-10						Work capac	Subjective outcome rating HAQ WBS McGill PQ CFQ
Stewart et al (2007) WADI/II	Exercise and advice v advice	66 (A) 68 (B)	3-12 months	6 weeks	3-12 months	6 weeks	12 months						NDI 0-50		PSFS GPE SF36 Work status
Vikne et al (2007) WADI/II	Traditional PT v trad PT plus home training v sling excs v sling excs plus home training	53 (A) 55 (B) 51 (C) 54 (D)	6-12 months plus 3 weeks	12 months	6-12 months plus 3 weeks	4 months post baseline	12 months post baseline	VAS 0-10	Mean (95% CI)	Mean (95% CI)			Mod RMDQ	Sick leave	Complaints HSCL neck stability kinaesthetic sensibility
Armstrong et al (2005) WADII/III	Cervical stability excs v control	* (A) * (B)	3 months – 5 years	1 session	3 months – 5 years	immedia tely									Head and neck position sense

Hansson et al (2000) WADII/III	Vestibular rehab v control	16 (A) 13 (B)	6 months – 15 years	6 weeks	6 months – 15 years	6 weeks and 3 months post baseline								4 balance measures
Soderland & Lindberg 2001 WADI/II/III	Individualised 4 phased RX + goal setting v Individualised excs + pain relief	16 (A) 17 (B)	3 months	Max 12 sessions	3 months	Immed post RX	3 months	NRS pain (0-10)	Mean (SD)	Mean (SD)	Mean (SD)	√	PDI 0-70	Kinaesthetic sensibility Cervico thoracic posture Patients perception of RX

Footnote: * = unclear in trial; excs = exercises; immed = immediately; CFQ = Cognitive Failures Questionnaire; CCFT = Cranio-Cervical Flexion Test; CSQ = Coping Strategies Questionnaire; ext = extension; flex = flexion; GHQ-28 = General Health Questionnaire 28; GPE = Global Perceived Effect; HAQ = Health Assessment Questionnaire; HSCL = Hopkins Symptom Checklist; IES = Impact of Events Scale; McGill = McGill Pain Questionnaire; NDI = Neck Disability Index; NFR = Nociceptive Flexion Reflex; NPRS = Numerical Pain Rating Scale; NRS = Numerical Rating Scale; PDI = Pain Disability Index; PCI = Patient Coping Inventory; PGIC = Patients' Global Impression of Change; PPT = Pressure Pain Threshold; PSFS = Patient Specific Functional Scale; RMDQ = Roland Morris Disability Questionnaire; Rot = rotation; ROM = Range of Motion; SF = Side Flexion; SD = standard deviation; SES = Self Efficacy Scale; SF36 = Short Form 36 Health Survey; TPT = Thermal Pain Threshold; Total ROM = sum of ROM in all 6 directions; TSK = TAMPA Scale of Kinesophobia; VAS = Visual Analogue Scale; WBS = Well-Being Scale; WAD = Whiplash Associated Disorders.

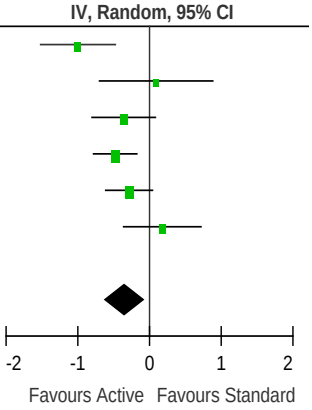
Figure 1: Study selection flow diagram (from Moher et al[20])



Study or Subgroup	Active intervention Mean	SD	Total	Standard intervention Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Denher 2009 (1)	4.7	9.51	32	15.7	12.12	32	14.9%	-1.00 [-1.52, -0.48]
Ask 2009	27	3.16	11	26.5	6.39	14	8.9%	0.09 [-0.70, 0.88]
Scholten-Peeters 2006	-23.3	29.8	38	-13.2	25.9	42	17.4%	-0.36 [-0.80, 0.08]
Vassiliou 2006	1.49	2.26	92	2.7	2.78	81	22.7%	-0.48 [-0.78, -0.18]
Schnabel 2004	1.04	1.81	88	1.6	2.15	62	21.8%	-0.28 [-0.61, 0.04]
Soderlund 2000	2.6	2.4	27	2.2	2	26	14.3%	0.18 [-0.36, 0.72]
Total (95% CI)			**288**			**257**	**100.0%**	**-0.35 [-0.63, -0.07]**

Heterogeneity: Tau² = 0.06; Chi² = 11.60, df = 5 (P = 0.04); I² = 57%

Test for overall effect: Z = 2.45 (P = 0.01)



(1) Scholten-Peeters reported change in pain

Figure 2 Pain

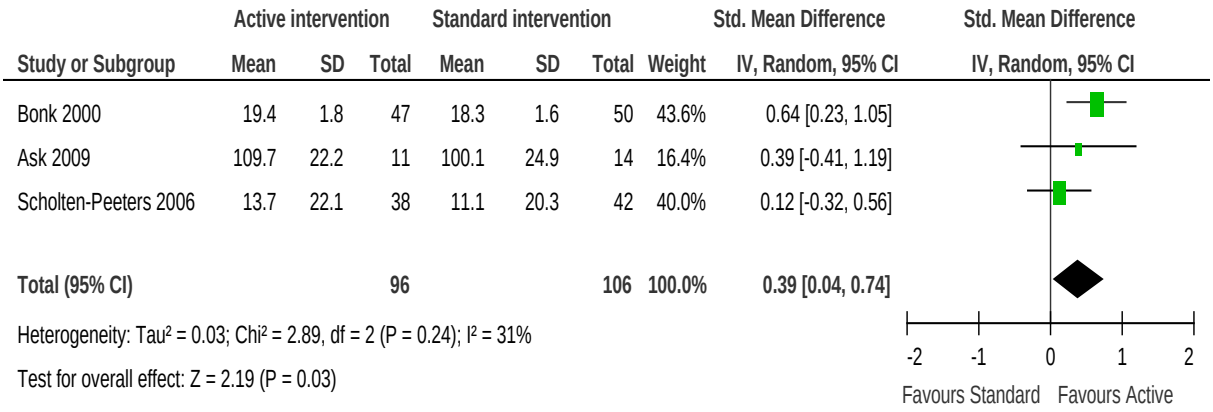


Figure 3 ROM Flexion/Extension

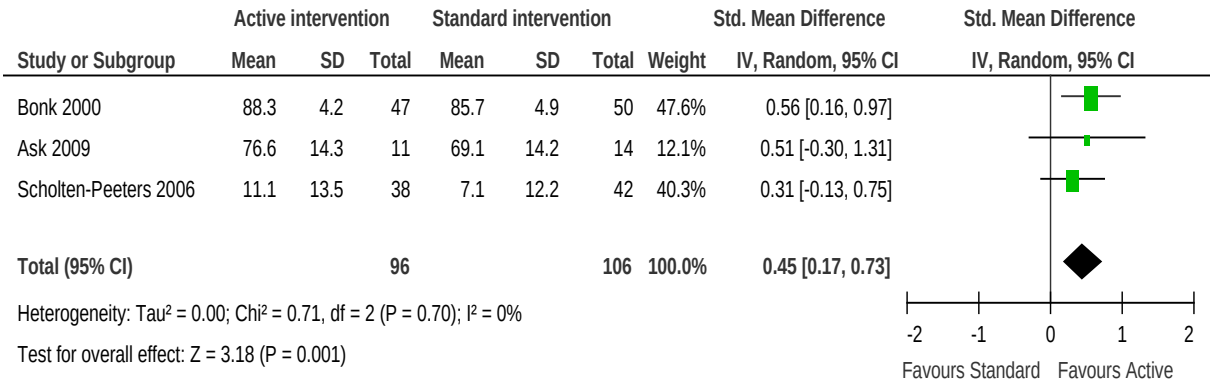


Figure 4 ROM RSF/LSF

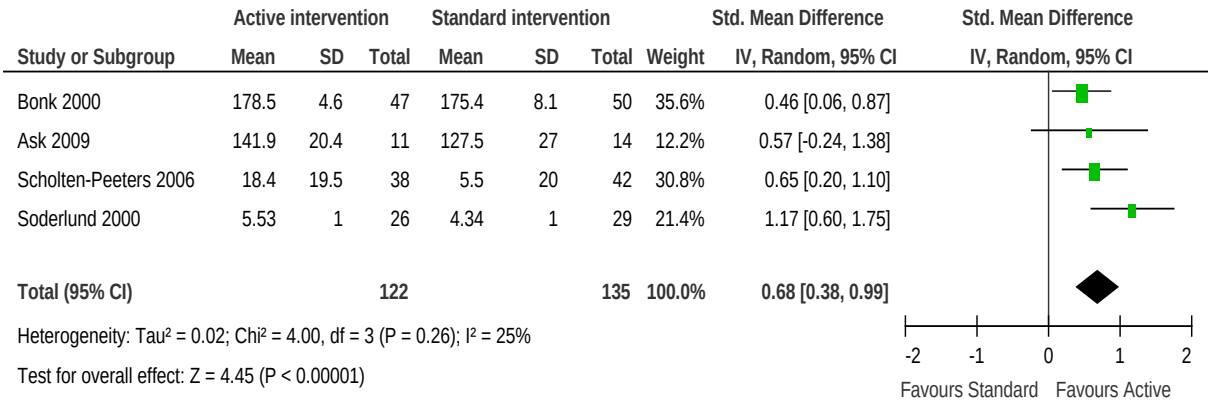


Figure 5 ROM Rotation R/L

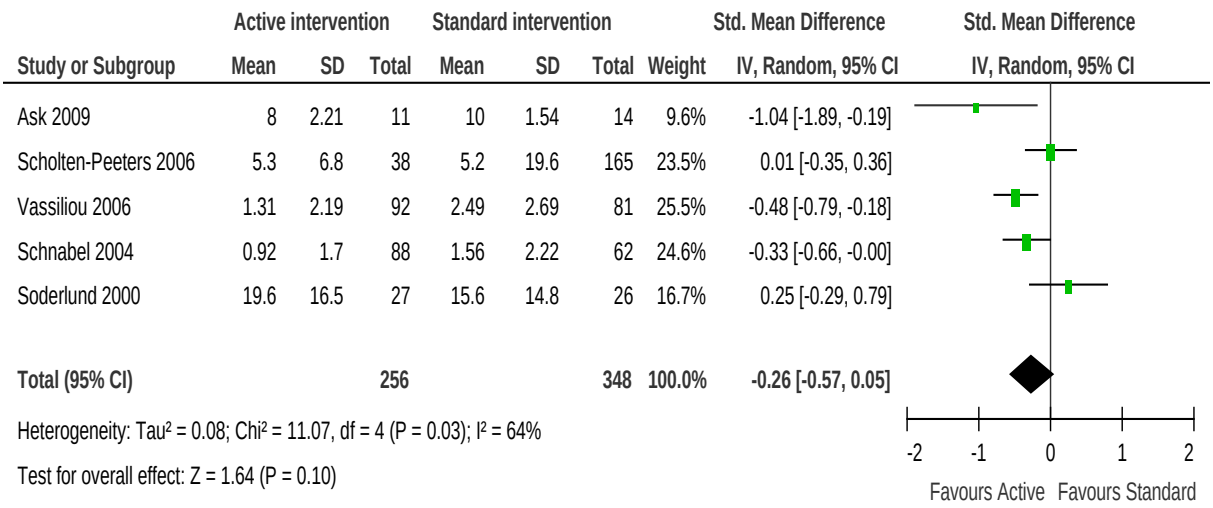


Figure 6 Disability

Table 1 Checklist of items to include when reporting a systematic review or meta-analysis

Section/topic	Item No	Checklist item	Reported on page No
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both	2
Abstract			
Structured summary	2	Provide a structured summary including, as applicable, background, objectives, data sources, study eligibility criteria, participants, interventions, study appraisal and synthesis methods, results, limitations, conclusions and implications of key findings, systematic review registration number	4-5
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known	7-8
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS)	8
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (such as web address), and, if available, provide registration information including registration number	9
Eligibility criteria	6	Specify study characteristics (such as PICOS, length of follow-up) and report characteristics (such as years considered, language, publication status) used as criteria for eligibility, giving rationale	9
Information sources	7	Describe all information sources (such as databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched	9-10
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated	10
Study selection	9	State the process for selecting studies (that is,	10

		screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis)	
Data collection process	10	Describe method of data extraction from reports (such as piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators	11
Data items	11	List and define all variables for which data were sought (such as PICOS, funding sources) and any assumptions and simplifications made	11
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis	11-12
Summary measures	13	State the principal summary measures (such as risk ratio, difference in means).	12
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (such as I^2 statistic) for each meta-analysis	12-13
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (such as publication bias, selective reporting within studies)	13
Additional analyses	16	Describe methods of additional analyses (such as sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified	13
Results			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram	13
Study characteristics	18	For each study, present characteristics for which data were extracted (such as study size, PICOS, follow-up period) and provide the citations	14-16
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see item 12).	16
Results of individual studies	20	For all outcomes considered (benefits or harms), present for each study (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot	17-18

Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency	17-18
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see item 15)	17
Additional analysis	23	Give results of additional analyses, if done (such as sensitivity or subgroup analyses, meta-regression) (see item 16)	n/a
Discussion			
Summary of evidence	24	Summarise the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (such as health care providers, users, and policy makers)	19-20
Limitations	25	Discuss limitations at study and outcome level (such as risk of bias), and at review level (such as incomplete retrieval of identified research, reporting bias)	20-21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research	21
Funding			
Funding	27	Describe sources of funding for the systematic review and other support (such as supply of data) and role of funders for the systematic review	21

BMJ open

Physiotherapy rehabilitation for Whiplash Associated Disorder II: a systematic review and meta-analysis of Randomised Controlled Trials

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2011-000265.R1
Article Type:	Research
Date Submitted by the Author:	26-Sep-2011
Complete List of Authors:	Rushton, Alison; University of Birmingham, School of Health and Population Sciences, College of Medical and Dental Sciences Wright, Chris; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Heneghan, Nicola; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Eveleigh, Gillian; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Calvert, Melanie; University of Birmingham, School of Health and Population Sciences College of Medicine and Dentistry Freemantle, Nick; UCL, PCPH
Primary Subject Heading:	Rehabilitation medicine
Keywords:	Physiotherapy, Whiplash injury, Systematic review

Title: Physiotherapy rehabilitation for Whiplash Associated Disorder II: a systematic review and meta-analysis of Randomised Controlled Trials

Authors: Rushton A, Wright C, Heneghan N, Eveleigh G, Calvert M, Freemantle N

Dr Alison Rushton
Senior Lecturer Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Mrs Chris Wright
Senior Lecturer, Nursing and Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Mrs Nicola Heneghan
Lecturer, Nursing and Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Mrs Gillian Eveleigh
Senior Lecturer, Nursing and Physiotherapy
School of Health and Population Sciences
College of Medicine and Dentistry
52 Pritchatts Road
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Dr Melanie Calvert
Senior Lecturer
School of Health and Population Sciences
College of Medicine and Dentistry
University of Birmingham
Edgbaston
Birmingham
B15 2TT

Professor Nick Freemantle
Professor of Clinical Epidemiology& Biostatistics
Department of Primary Care and Population Health

Upper Third Floor
UCL Medical School (Royal Free Campus)
Rowland Hill Street
London
NW3 2PF

ADDRESS FOR CORRESPONDENCE:
Address a/a

Alison Rushton

Email: a.b.rushton@bham.ac.uk
Tel: 0121 415 8597

Competing Interest Declaration

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that they have no competing interests.

Sources of funding

No funding was received to support this work.

Contributors

Contributors: AR and GE are Senior Lecturers in Physiotherapy and NH is a Lecturer. MC and CW are both Senior Lecturers. NF is Professor of Clinical Epidemiology and Biostatistics. AR, MC, CW and NF have longstanding professional interests in the quality and reporting of randomised controlled trials in medicine and physiotherapy. AR, NH and GE have a professional focus to musculoskeletal physiotherapy. AR and CW were responsible for the conception of the study. All authors have contributed to the systematic review and have been involved in developing the content of the article. AR wrote the first draft of the paper and developed it initially with CW. AR has worked with all authors reworking content into subsequent drafts. All authors gave final approval of the version to be published. AR is the guarantor.

ABSTRACT

Objective

To evaluate effectiveness of physiotherapy management in patients experiencing Whiplash Associated Disorder II, on clinically relevant outcomes in the short and longer term.

Design

Systematic review and meta-analysis. Two reviewers independently searched information sources, assessed studies for inclusion, evaluated risk of bias, and extracted data. A third reviewer mediated disagreement. Assessment of risk of bias was tabulated across included trials. Quantitative synthesis was conducted on comparable outcomes across trials with similar interventions. Meta-analyses compared effect sizes, with random effects as primary analyses.

Data sources

Pre-defined terms were employed to search electronic databases. Additional studies were identified from key journals, reference lists, authors and experts.

Eligibility criteria for selecting studies

RCT published in English before 31/12/2010 evaluating physiotherapy management of patients (>16 years), experiencing Whiplash Associated Disorder II. Any physiotherapy intervention was included, when compared with other types of management, placebo/sham, or no intervention. Measurements reported on ≥1 outcome from the domains within the international classification of function, disability, and health, were included.

Results

21 RCTs (2126 participants, 9 countries) were included. Interventions were categorised as active physiotherapy or a specific physiotherapy intervention. 20/21 trials were evaluated as high risk of bias and

1 as unclear. 1395 participants were incorporated in the meta-analyses on 12 trials. In evaluating short term outcome in the acute/sub-acute stage, there was some evidence that active physiotherapy intervention reduces pain and improves range of movement, and that a specific physiotherapy intervention may reduce pain. However, moderate/considerable heterogeneity suggested that treatments may differ in nature or effect in different trial patients. Differences between participants, interventions, and trial designs limited potential meta-analyses.

Conclusions

Inconclusive evidence exists for the effectiveness of physiotherapy management for Whiplash Associated Disorder II. There is potential benefit for improving range of movement and pain short term through active physiotherapy, and for improving pain through a specific physiotherapy intervention.

Article summary

Article focus

- Physiotherapy intervention is recommended in Whiplash Associated Disorder II, although the most beneficial intervention and the effectiveness of physiotherapy management are unclear.
- Systematic reviews have not focused on Whiplash Associated Disorder II that represents approximately 93% patients presenting for management post whiplash injury.
- The objective of this systematic review was to evaluate the effectiveness of physiotherapy management in patients experiencing Whiplash Associated Disorder II, on clinically relevant outcomes in the short and longer term.

Key messages

- This systematic review demonstrates inconclusive very low / low quality evidence for the effectiveness of physiotherapy management for Whiplash Associated Disorder II.
- There is potential benefit for improving pain and range of movement short term through active physiotherapy and for improving pain through specific physiotherapy interventions.
- This potential benefit merits further consideration in a properly powered clinical trial with attention to ensure low risk of bias.

Strengths and limitations of this study

- The strengths of this review are its focus to physiotherapy intervention and the most common Whiplash Associated Disorder II classification requiring physiotherapy intervention.

- A limitation is that differences between participants, interventions, and trial designs limited potential meta-analyses.
- Surprisingly, no chronic interventions were comparable for analysis, considering the high number of patients experiencing chronicity with Whiplash Associated Disorder.

INTRODUCTION

Road traffic accidents are the primary cause of whiplash, a soft tissue injury to the neck following an acceleration-deceleration mechanism of injury.[1] The cumulative incidence of patients seeking healthcare post whiplash from a road traffic accident has increased during the last 30 years to recent estimates of >3 in 1000 inhabitants in North America and Western Europe[2] and 1.0-3.2/1000 inhabitants in Sweden.[3] In the UK, insurance statistics indicate that 300,000 patients present per annum with Whiplash Associated Disorders.[4] Whiplash Associated Disorders are the resulting clinical presentations following the injury and can range in severity, clinical symptoms and physical findings.[1] Many patients with Whiplash Associated Disorders experience persistent pain and disability, with reports suggesting that 40-60% of those injured have chronic symptoms.[5 6 7 8] The annual economic costs associated with management of Whiplash Associated Disorders and associated time off work is estimated as $3.9 billion in the US,[9] and €10 billion in Europe.[10]

Patients experiencing Whiplash Associated Disorders may be regarded as a distinct group within the broader non-specific neck pain population,[1 2 7 11 12 13] although following review of trial data (n=4 trials), recent evidence questions this distinction for a primary care population and has identified a need for further research. [14] Whiplash Associated Disorders can be categorised as grade 0 to IV,[1] where a higher grade indicates increased severity. The classification system is widely used in clinical practice[15] and guidelines.[16] Patients with Whiplash Associated Disorder II who experience neck pain accompanied by stiffness or tenderness, and musculoskeletal sign(s), for example a reduced range of available movement, form the major group of patients (93.4%)[15] who might benefit from conservative management; commonly involving physiotherapy intervention. A recent best evidence synthesis[3] recommended a focus of research to the most common Whiplash Associated Disorder I and II classifications, excluding classification III and above (i.e. patients with neurological signs and fracture and/or dislocation) and classification 0 (no complaint at the neck, and no physical signs).[1] However, a classification of Whiplash Associated Disorder I is

less commonly seen by physiotherapists as there are no accompanying physical findings (neck pain, stiffness or tenderness but with no physical findings) and patients are known to recover within 6 months post injury.[15]

Evidence of the effectiveness of physiotherapy intervention for the treatment of Whiplash Associated Disorder II is scarce. Existing systematic reviews instead tend to focus on a range of Whiplash Associated Disorder classifications, a broad range of conservative intervention strategies such as educational videos, include studies of non traumatic neck pain, and lack rigorous assessment of the risk of bias of included studies. The most robust evidence, a Cochrane review,[17] on the management of Whiplash Associated Disorder I/II patients does not specifically assess physiotherapy. No review has included trials published post 2006. The effectiveness of physiotherapy for the Whiplash Associated Disorder II population is therefore unclear.

Objectives

To investigate the short and longer term effectiveness of physiotherapy outpatient management of patients presenting with Whiplash Associated Disorder II, in terms of function, disability, and health,[18] in patients aged >16 years.

MATERIALS AND METHODS

A systematic review was conducted according to a pre-defined protocol based on the method guidelines by the Back Review Group of the Cochrane Collaboration[19] and the Cochrane handbook.[20] It is reported in line with the PRISMA statement.[21]

Eligibility criteria

S*tudies*: RCTs evaluating the effectiveness of physiotherapy outpatient management of patients experiencing Whiplash Associated Disorder II. Studies not written in English were excluded rather than restricting the inclusion of studies, thereby providing information of potential bias.[22] No restrictions were placed on publication date.

Participants: Patients who had experienced a whiplash injury and were classified as Whiplash Associated Disorder II, aged >16 years. Acute and chronic presentations were included and analysed separately. Mixed populations of different classifications of Whiplash Associated Disorder were included if patients presenting with Whiplash Associated Disorder II formed part of the population.

Interventions: Any physiotherapy outpatient management intervention.

Outcome measures: Measures addressing domains within the international classification of function, disability, and health,[18] in the short term (approximately 3 months post injury/intervention) and/or longer term (approximately 12 months).

Information sources

Each database was searched using sensitive topic based search strategies to the end of December 2010:

- The Cochrane Library: Controlled Trials Register, Health Technology Assessment Database, NHS Economic Evaluation Database.

- CINAHL, EMBASE, MEDLINE, PEDro, ZETOC databases
- Selected Internet sites and Indexes: Turning Research into Practice, Health Services/Technology Assessment, PUBMED.
- National Research Register, Current Controlled Trials website (York).
- Cochrane Back Review Group.
- Cochrane Cervical Overview Group.
- Hand searches in key journals e.g. Spine, Manual Therapy, Physiotherapy, Physical Therapy, Australian Journal of Physiotherapy.
- Science Citation Index and Social Science Citation Index.
- Unpublished research:[22] British National Bibliography for Report literature, Dissertation Abstracts, Index to Scientific and Technical Proceedings, National Technical Information Service, System for Information on Grey Literature.
- Personal citation for key authors in the field.

Search

The search employed pre-defined terms. Table 1 provides two examples of the searches utilised.

Table 1: Examples of search strategies

Medline (Ovid) 1948 – 31st December, 2010	
1	acute whiplash or cervical spine disorder or cervical spine injury.mp
2	manual therapy or manipulation or massage.mp
3	clinical trial or randomised controlled trial or RCT.mp
4	1 and 2
5	3 and 4
6	WAD II or whiplash associated disorders or whiplash injury or whiplash patients or whiplash syndrome.mp
7	2 and 6
8	3 and 7
9	Conservative approach or conservative intervention or conservative management or conservative therapy.mp
10	Physical approach or physical intervention or physical management or physical therapy.mp

11	Exercise or active range of motion exercise$ or strengthening exercise$ or stretching exercise$ or therapeutic exercise$ or endurance training or home exercise$ or proprioception exercise$
12	Transcutaneous electrical nerve stimulation or TENS or thermotherapy or electrical stimulation or heat or electrotherapy.mp
13	Pain management program$.mp
14	Patient education or educational or self management program$.mp
15	Posture or (postural and balance) or traction.mp
16	1 and 9
17	3 and 16
18	6 and 9
19	3 and 18
20	1 and 10
21	3 and 20
22	6 and 10
23	3 and 22
24	1 and 11
25	3 and 24
26	6 and 11
27	3 and 26
28	1 and 12
29	3 and 28
30	6 and 12
31	3 and 30

Embase (Ovid) 1947 – 31st December, 2010

1	acute whiplash or cervical spine disorder or cervical spine injury.mp
2	manual therapy or manipulation or massage.mp
3	clinical trial or randomised controlled trial or RCT.mp
4	1 and 2
5	3 and 4
6	WAD II or whiplash associated disorders or whiplash injury or whiplash patients or whiplash syndrome.mp
7	2 and 6
8	3 and 7
9	Conservative approach or conservative intervention or conservative management or conservative therapy.mp
10	Physical approach or physical intervention or physical management or physical therapy.mp
11	Exercise or active range of motion exercise$ or strengthening exercise$ or stretching exercise$ or therapeutic exercise$ or endurance training or home exercise$ or proprioception exercise$
12	Transcutaneous electrical nerve stimulation or TENS or thermotherapy or electrical stimulation or heat or electrotherapy.mp
13	Pain management program$.mp
14	Patient education or educational or self management program$.mp
15	Posture or (postural and balance) or traction.mp
16	1 and 9
17	3 and 16
18	6 and 9
19	3 and 18
20	1 and 10

21 3 and 20
22 6 and 10
23 3 and 22
24 1 and 11
25 3 and 24
26 6 and 11
27 3 and 26
28 1 and 12
29 3 and 28
30 6 and 12
31 3 and 30

Study selection

Two subject experts independently searched information sources (GE/NH), and independently assessed identified studies for inclusion by grading each criterion (Table 2) as eligible/not eligible/might be eligible.[19] A study was potentially relevant and its full text was obtained, when it could not be unequivocally excluded on the basis of its Title and Abstract[22] following discussion between the two independent reviewers. In a situation of disagreement or when abstracts contained insufficient information the full text was obtained. A study was included in the review when both reviewers independently assessed it as satisfying the inclusion criteria from the full text. If agreement was not obtained, a third reviewer (AR, subject and methodological expert) mediated following discussion.[19]

Table 2: Criteria for inclusion and exclusion of studies in the review

	Criteria
Inclusion criteria	
Study Design	RCT
Population	
Age	16 years or older
Subjects	Human; outpatients
Condition	Post whiplash injury

	Experiencing Whiplash Associated Disorder II
Intervention	Conservative physiotherapy outpatient management
Comparison group(s)	At least one comparison group, either placebo / other intervention / no intervention
Outcome	Measurement on at least one of the following outcomes: disability; functional status; physical impairment; impact on social and occupational levels of fitness; pain; quality of life; patient satisfaction
	Measurement of short term outcome (approx 3 months post surgery) and / or long term outcomes (≥1year post surgery)
Time frame	All studies conducted from 1979 onwards

Exclusion criteria

Study Design	Initial search: • Studies stated as RCTs but do not have a comparison group or random allocation to groups
Participant characteristics	Multiple pathology Whiplash Associated Disorder not classified according to severity to provide clarity of Whiplash Associated Disorder II population
Intervention	none
Outcome	none
Language	Full article not written in English

Risk of bias was independently assessed by the same reviewers for each included study. Risk of bias, and homogeneity of participants, interventions, and outcomes were key considerations informing the potential for including trials in meta-analyses, in line with Cochrane.[20] The third reviewer again mediated.[20] Agreement between reviewers was evaluated using Cohen's Kappa.[23] All processes and tools were piloted.

Data collection process

Two reviewers (AR/CW) independently extracted the data[20 24] using a standardised form. A third independent reviewer (NH) checked for consistency and clarity.

Data items

Data extracted for each trial included: design, participants and indication, Whiplash Associated Disorder categorisation, interventions, study setting, outcome measures, timing of assessments, power calculations, loss to follow up, intention to treat analyses and main results. Key outcome measures were pre-defined as valid tools to measure pain, disability, function, physical impairment, social impact and patient satisfaction, reflecting domains from the International Classification of Functioning, Disability and Health.[18] Based on recommendations, a maximum of two primary outcomes were considered acceptable,[25] when more than one primary outcome was reported and alpha spend was not considered.

Risk of bias in individual studies

The Cochrane 'risk of bias' assessment tool was used to appraise the internal validity of each included trial.[21 26] In contrast to the majority of quality scales used in health research,[21 27 28] the Cochrane tool is informed by empirical research.[26] Each component of bias was reported independently and considered with regard to each key outcome measure.[26 29] The component including 'blinding' the treating therapist has been acknowledged as generally impossible[26] and this formed part of the appraisal by the reviewers as the Cochrane tool also permits evaluation of the likely influence of any lack of blinding. The rigour of the risk of bias assessment was ensured through strict application of the defined criteria to inform conclusions, making explicit the trials of high risk of bias or poor reporting.[30]

Summary measures

Quantitative synthesis was conducted in line with the protocol on comparable key outcomes across trials evaluating similar interventions (nature of intervention, and timing of assessments at approximately 3 months and/or 12 months post injury or intervention). Results were reported in the context of overall risk of bias. Comparable outcomes were defined as tools developed to measure the same underlying domain. Two subject experts and two methodological experts identified the combinations of studies and outcomes on which to conduct meta-analyses.

Using RevMan,[31] meta-analyses compared standardised differences in means using DerSimonian-Laird random effects[32] for the principal analyses to allow for systematic differences in effects estimated across the included trials.[22 32] 95% confidence intervals were reported for summary statistics. Standardised mean differences were selected to make comparisons across studies that used different tools to measure the same outcome,[22] or reported a mixture of final value scores and change from baseline scores.[33] Hedges-Olkin fixed effects[34] were used as the supportive analyses.

Planned methods of analysis

Data were requested from all authors, except for those with no comparability of outcome measures to other trials.[35 36] Data defined by Whiplash Associated Disorder classification was also requested from all authors of trials that reported combined Whiplash Associated Disorder classifications. Analyses were conducted on final summary statistics when reported or the raw data where supplied. When necessary, standard deviations were estimated from reported confidence intervals or percentiles.[33] In-line with the use of random effects as primary analyses,[32] change scores were used for studies when no other data were forthcoming. Heterogeneity in treatment effects was evaluated through computation of I^2.

Risk of bias across studies

A summary assessment for risk of bias was tabulated across studies, and consensus agreed concerning the overall potential risk of bias. It was not helpful to attempt to assess potential publication bias visually using Funnel plots[22] as less than 10 trials were included in meta-analyses.[37]

Additional analyses

No post hoc supportive analyses were conducted owing to the inconsistency of outcome measures across the trials.

RESULTS

Study selection

Included trials were grouped according to the Whiplash Associated Disorder classification[1] into 5 categories:

Whiplash Associated Disorder II: 5 articles and 5 trials,[36 38 39 40 41] from 4 countries were included.

Whiplash Associated Disorders I/II: 8 articles and 8 trials, [42 43 44 45 46 47 48 49] from 6 countries were included.

Whiplash Associated Disorders II/III: 4 articles and 4 trials,[35 50 51 52] from 3 countries were included.

Whiplash Associated Disorders 0/I/II: 3 articles and 2 trials,[53 54 55] from 2 countries were included.

Whiplash Associated Disorders I/II/III: 3 articles and 2 trials,[56 57 58] from 1 country were included.

Most retrieved trials were published in English with only 2 in other languages. One relevant unpublished study was found (Managing Injuries of the Neck Trial, accessible at http://www.hta.ac.uk/1399 due to be published 2011). Figure 1 presents the numbers of studies at each stage of selection. Complete inter-reviewer agreement was achieved on study inclusion across all categories following discussion.

[Insert Figure 1 here]

Study characteristics

Descriptive data for the 21 included trials are summarised in Table 3.

[Insert Table 3 near here – see end of text for Table]

Methods

Eighteen trials randomised participants across 2 groups, 1 trial across 3 groups, and 2 trials across 4 groups. Eight trials compared a specific physiotherapy intervention, for example manipulation, to no management, sham or placebo. Thirteen trials compared an active physiotherapy intervention to standard care, and the active approaches were characterised by additional interventions, a multimodal intervention, or a progressive intervention. Duration of interventions ranged from one treatment session to 12 months. The number of assessments varied from 1-4, occurring immediately post treatment to 3 years.

Participants

The 21 trials randomised 2126 participants. Age varied from 16-70 years. 271/2126 participants were randomised in trials focused to Whiplash Associated Disorder II[1]. Of the authors who responded, no authors were able to provide data for their included Whiplash Associated Disorder classifications separately. In the 8 Whiplash Associated Disorder I/II category trials, 934 participants were randomised but no distinction of Whiplash Associated Disorder II participants was possible. In the 4 Whiplash Associated Disorder II/III category trials, 333/409 (81.5%, 2 trials) participants were classified as Whiplash Associated Disorder II, with a further 111 participants (2 trials) with no distinction of Whiplash Associated Disorder II participants possible. In the 2 Whiplash Associated Disorder O/I/II category trials, 302 participants were randomised with no distinction of Whiplash Associated Disorder II participants possible. In the 2 Whiplash Associated Disorder I/II/III category trials, 49/66 (74%, 1 trial) participants were classified as Whiplash Associated Disorder II, with a further 33 participants (1 trial) with no distinction of Whiplash Associated Disorder II participants possible. 1395 participants were randomised in the 12 trials included in the meta-analyses.

Interventions

Eight trials were conducted at single-centres that included physiotherapy clinics or outpatient departments. Both a clinic and home setting were used in 1 trial. The setting was unclear in 12 trials. One trial

[1] In Aigner et al (2006)[38], three subject experts agreed that the Kramer grade II evaluated as equivalent to the WADII classification.

investigated a group intervention. Interventions could be grouped according to whether they were a specific physiotherapy intervention or an active intervention comprising different components. Timing of interventions included acute/sub-acute (13 trials) and chronic stages (8 trials), ranging from 2 days to 15 years post injury.

Primary outcomes

Only 6 (28.5%) trials specified primary outcomes *a priori* that included: Neck Pain and Disability Index, Nociceptive Flexion Reflex, Neck Disability Index, Pain Visual Analogue Scale (VAS), Pain VAS and work activities VAS, and Pain VAS and Disability VAS. One trial[46] specified 3 primary outcome measures with no adjustment for alpha spend and was therefore evaluated as unacceptable in specifying primary outcomes.[25]

Secondary and additional outcomes

Most trials reported some assessment of pain (general or specific to the neck) (15 trials), and range of movement (ROM) (13 trials). Nine trials reported assessment of disability. A wide range of other outcomes included: work status, SF36, Tampa, patient satisfaction, muscle stability, posture, and kinaesthetic sensibility. Two trials reported outcomes that were not consistent with any other trial for example, temperature pain threshold[36] and the tandem standing balance test.[35]

Risk of bias within studies

'Almost perfect'[59] 93% inter-reviewer agreement was achieved on risk of bias assessment prior to discussion (Cohen's Kappa[23] k = 0.90, p<.0005) and 100% agreement was reached following discussion. Only 2 trial protocols were available.[60 61] Of the 21 included trials, 20 were evaluated as high risk of bias and 1 as unclear risk of bias (Table 4). The very high proportion of trials identified as high risk of bias should affect the interpretation of results.[26]

Table 4: Summary Assessment of the overall risk of bias for each trial

Study (authors, year, country)	Components of risk of bias							Summary risk of bias	Comments high risk components
	1	2	3	4	5a	5b	6		
WAD II									
Aigner et al (2006)	U	U	U	U	U	U	H	**High (1)** Unclear (6)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Dehner et al (2009)	L	L	U	U	U	N/A	H	**High (1)** Unclear (3) Low (2) N/A (1)	One high risk component: 6 Design problematic with comparison to a previous non-randomised group. Assessment ROB excluded previous group. No primary outcome measure specified No primary endpoint specified No ITT reported
Gonzalez-Inglesias et al (2009)	L	L	L	L	U	N/A	H	**High (1)** Unclear (1) Low (4) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Jull et al (2007)	L	L	L	L	U	N/A	L	**Unclear (1)** Low (5) N/A (1)	No high risk components
Sterling et al (2010)	L	U	L	L	U	N/A	H	**High (1)** Unclear (2) Low (3) N/A (1)	One high risk component: 6 No ITT reported
WAD I/II									
Ask et al (2009)	U	L	L	L	U	U	H	**High (1)** Unclear (3) Low (3)	One high risk component: 6 No primary endpoint specified
Bonk et al (2000)	U	U	H	L	U	N/A	H	**High (2)** Unclear (3) Low (1) N/A (1)	Two high risk components: 3, 6 3 Assessors not blinded beyond baseline. 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Pato et al (2010)	U	U	L	L	U	N/A	H	**High (1)** Unclear (3) Low (2) N/A (1)	One high risk component: 6 No primary endpoint specified No ITT reported
Scholten-Peeters et al (2006) [Scholten-Peeters et al (2003) trial protocol]	L	L	L	L	L	L	H	**High (1)** Low (6)	One high risk component: 6 No primary endpoint specified
Stewart et al (2007) [Stewart et al (2003) trial protocol]	L	L	L	L	L	N/A	H	**High (1)** Low (5) N/A (1)	One high risk component: 6 Co-interventions by 6 weeks: A: n=10 (15%) and B: n=15 (23%) reported seeking additional treatment. Co-interventions by 12 months: A: n=18 (29%) and B: n=35 (56%) reported seeking additional treatment. No primary outcome measure specified No primary endpoint specified
Thuile and Walzl (2002)	U	U	U	U	U	N/A	H	**High (1)** Unclear(5) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported Poor reporting, lacking detail across all components
Vassiliou et al (2006)	L	L	L	H	U	N/A	H	**High (2)** Unclear (1) Low (3) N/A (1)	Two high risk component: 4, 6 4: Losses at 6 weeks (6 months): A: 15%(30%) B: 36%(46%) n=12 (6%) participants excluded due to incomplete outcome data. 6: No primary endpoint specified

Vikne et al (2007)	U	L	L	H	U	U	H	**High(2)** Unclear(3) Low (2)	Two high risk components: 4, 6 4: Losses of 20% at 12 months (10% at 4 months) 6: No primary outcome measure specified No primary endpoint specified No ITT reported
WAD II/III									
Armstrong et al (2005)	U	U	U	L	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 Problematic design and data analysis combining groups. No primary outcome measure specified No ITT reported
Fernandez-de-las-Penas (2004a)	L	U	U	U	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported Selection bias as participants were volunteers
Fernandez-de-las-Penas (2004b)	L	U	U	U	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Hansson et al (2000)	L	L	L	H	U	N/A	H	**High (2)** Unclear (1) Low (3) N/A (1)	Two high risk components: 4, 6 4: Drop outs 38%. 6: Differences at baseline on two outcomes No primary outcome measure specified No primary endpoint specified No ITT reported
WAD 0/I/II									
Rosenfeld et al (2003) [Rosenfeld et al (2006) reporting same trial]	U	L	L	H	U	U	H	**High (2)** Unclear (3) Low (2)	Two high risk components: 4, 6 4: High loss to follow up. Drop out at 6 months (and 3 years): 8% (13%). Exclusions at 6 months (and 3 years): 11% (8%). Includes eligibility errors with participants excluded post randomisation for not meeting inclusion criteria. 6: Co-interventions: 25% participants received treatment outside of study by 6 months; nearly 50% by 3 years. No primary outcome measure specified No primary endpoint specified
Schnabel et al (2004)	H	U	U	H	U	N/A	H	**High (3)** Unclear(3) N/A (1)	Three high risk components: 1, 4, 6 1: Inappropriate method of randomisation. 4: Loss to follow up from groups: A: 36% B: 15% 6: No primary outcome measure specified No ITT reported
WAD I/II/III									
Soderlund et al (2000)	U	U	U	L	U	N/A	H	**High (1)** Unclear (4) Low (1) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported
Soderlund and Lindberg (2001) [Soderlund and Lindberg (2007) reporting same trial]	U	U	L	L	U	N/A	H	**High (1)** Unclear (3) Low (2) N/A (1)	One high risk component: 6 No primary outcome measure specified No primary endpoint specified No ITT reported

Footnotes: Components of risk of bias **: 1** Sequence generation; **2** Allocation concealment**; 3** Blinding of participants, personnel and outcome assessors; **4** Incomplete outcome data; **5a** Short term selective outcome reporting; **5b** Long term selective outcome reporting; **6** Other potential threats to validity. Levels of risk of bias: H high risk of bias; U unclear risk of bias; L low risk of bias. N/A: Not Applicable, no investigation of long term outcome

Risk of bias across studies

Only trials evaluated as high risk of bias were available for meta-analysis. Although reasons for the high risk components provided concern for potential bias, results from meta-analyses evaluated critically within this context enabled an overview of the evidence to be presented, strength of effect to be presented, and tentative conclusions to be proposed to advance research.

Results of individual studies and synthesis of results

Comparability of interventions, timing of assessments and outcome measures were considered to determine appropriate quantitative syntheses of trials.[22] In exploring the compatibility of outcomes for management in the acute/sub-acute and chronic stages; no possible quantitative syntheses within the five categories of Whiplash Associated Disorders were possible. No further information regarding Whiplash Associated Disorder classification was provided by authors to assist potential comparisons regarding Whiplash Associated Disorder II. In comparing across categories, no comparison was possible for intervention in the chronic stage or long term. The following meta-analyses were conducted in the acute/sub-acute stage in the short term:

- Active intervention v standard intervention for: pain, 4-12 weeks (n=6 trials); ROM flexion/extension (flex/ext), 12 weeks (n=3 trials); ROM rotation (Rot), 12 weeks (n=4); ROM side flexion (SF), 12 weeks (n=3); Total ROM, 4-12 weeks (n=3)[2]; Disability, 6-12 weeks (n=5).
- Specific intervention v control post intervention for: pain (n= 4 trials)[3]; ROM flex/ext, ROM Rot, and ROM SF (n=3 trials)[4].

Active versus standard intervention short term:

[2] Excluded Rosenfeld et al (2003;2006)[53 54] as short term assessment was 6 at months.
[3] Included Thuile and Walzl (2002)[47] although timing of intervention and assessment was unclear from trial.
[4] Aigner et al[38] n=5 LTFU but not clear from which group.

Evidence from 2 trials[39 48] suggested that intervention might reduce pain, with active intervention being beneficial compared to standard intervention (Figure 2). This was not supported by 4 trials.[42 45 55 56] The pooled random effects (-0.35, 95%CI -0.63 to -0.07) did support evidence of an effect short term. Evidence from 1 trial[43] suggested that intervention might improve ROM flex/ext and ROM SF, with active intervention being beneficial compared to standard intervention (Figures 3 and 4). This was not supported by 2 trials.[42 45] The pooled random effects (ROM flex/ext: 0.39, 95%CI 0.04 to 0.74; ROM SF: 0.45, 95%CI 0.17 to 0.73) did support evidence of an effect short term. Evidence from 3 trials[43 45 56] suggested that intervention might improve ROM Rot, with active intervention being beneficial compared to standard intervention (Figure 5). This was not supported by 1 trial.[42] The pooled random effects (0.68, 95%CI 0.38 to 0.99) did support evidence of an effect short term.

Overall, there was no evidence of short term benefit of active over standard intervention on total ROM (pooled random effects 0.28, 95%CI -0.03 to 0.59) or disability (Figure 6: -0.26, 95%CI -0.57 to 0.05).

[Insert Figures 2-6 near here]

Specific physiotherapy intervention versus control:

Evidence from 4 trials [40 47 51 52] suggested that intervention might reduce pain short term, with specific physiotherapy intervention being beneficial compared to control. The pooled random effects (-2.11, 95%CI -3.85 to -0.36) did support evidence of an effect short term. Overall, there was no evidence of short term benefit of specific physiotherapy intervention over control on ROM flex/ext (pooled random effects 0.83, 95%CI -3.79 to 5.44) or ROM Rot (pooled random effects -1.02, 95%CI -3.73 to 1.68) or ROM SF (pooled random effects -1.21, 95%CI -3.11 to 0.69).

DISCUSSION

Summary of evidence

Evidence was assessed from 21 RCTs (2126 participants) conducted across 9 countries. Only 1 trial investigated a group intervention. Interventions were grouped into active v standard intervention, and specific physiotherapy intervention versus control. No meta-analyses were possible exclusively on a Whiplash Associated Disorder II population, as most trials included combined classifications of Whiplash Associated Disorders in their populations. Disappointingly, as many trials were recent, 20/21 trials were assessed as high risk of bias, and 1 as unclear risk. All 12 trials (1395 participants from 6 countries) included in the meta-analyses were assessed as high risk. Comparable outcomes across trials included pain, ROM flex/ext, ROM Rot, ROM SF, total ROM, and disability in the short term. There was no evidence beyond individual results of benefit in the longer term as no meta-analyses were possible. The one trial that evaluated as unclear risk of bias was, therefore, not included in any meta-analyses.[41]

In evaluating short term outcome in the acute/sub-acute stage, there was some evidence that active physiotherapy intervention reduces pain. This was supported by statistically significant differences in 2 trials.[39 48] Although the finding is interesting, further trials are required since one trial possessed one high risk component of bias and the other two. Only 1 trial[43] suggested that active physiotherapy intervention changes ROM (flex/ext and SF), and 3 trials[43 45 56] suggested a change in ROM Rot. There was evidence from the meta-analyses to support this. Again, risk of bias was high for all trials, with two high risk components for one trial[43] and one high risk component for the two other trials. There was no evidence that active physiotherapy intervention affects disability.

In evaluating short term outcome in the acute/sub-acute stage, there was some evidence that specific physiotherapy intervention reduces pain. This was supported by statistically significant differences found in 4 trials[40 47 51 52] using interventions of Kinesio Taping, magnetic therapy and manipulation.

Although the finding is interesting, further trials are required because all trials possessed one high risk component of bias and two trials had an additional 4 unclear risks. Only one individual trial[47] suggested that specific physiotherapy intervention (magnetic therapy) changes ROM (flex/ext or Rot or SF) in the short term. There was no evidence from the meta-analyses to support this.

Limitations

The strengths of this review are its focus to physiotherapy intervention and the most common Whiplash Associated Disorder II classification requiring physiotherapy intervention. Heterogeneity in treatment effects can be explained by variation in the quality of administration of interventions. Differences were evident in the outcome measures, assessment points, and classification of Whiplash Associated Disorder participants, where many trials combined Whiplash Associated Disorder classifications even though interventions in practice would vary between classifications.[15 16] Differences in components of the physiotherapy interventions were also evident with some variation explained by diversity in practice across countries. The differences limited the possible comparisons in the meta-analyses. Surprisingly, no chronic interventions were comparable for analysis, considering the high number of patients experiencing chronicity with Whiplash Associated Disorder.[7 8] Also surprisingly, work status was not possible for analysis considering the economic implications of Whiplash Associated Disorder.[9 10]

Moderate heterogeneity (I^2 57%) was present in the evidence for active intervention for pain[33] identifying significant difference in treatment effects between trials. However, heterogeneity might not be important for ROM flex/ext, Rot, and SF (I^2 31%, 25%, 0% respectively). Substantial heterogeneity (I^2 64%) was present in the evidence for active intervention for disability perhaps explaining no evidence of an effect. Considerable heterogeneity[33] was present in the evidence for specific physiotherapy intervention for pain, ROM flex/ext, Rot, and SF (I^2 98.1%, 99.0%, 98.1%, and 96.6% respectively), perhaps explaining no evidence of an effect for all ROM evaluations. This anticipated heterogeneity was accounted for by using the random effects model.

Using GRADE[62] (The Grading of Recommendations Assessment, development, and Evaluation system) the quality of the body of evidence for physiotherapy rehabilitation in the management of Whiplash Associated Disorder II, based on the 12 trials included in the meta-analyses, is 'very low' for pain, ROM flex/ext and SF (active versus standard intervention), and 'low' for ROM Rot (active versus standard intervention) and pain (specific intervention versus control) in the short-term. These estimates are interpreted as "little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect" (very low) and "confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect" (low).[62] Downgrading of quality was due to high risk of bias, and issues of imprecision and inconsistency.[62]

The limitations in the context of the high risk of bias and number of trials available necessitate urgent attention to focus a future high quality and properly powered trial to evaluate a Whiplash Associated Disorder II population. The very low / low quality of trials is consistent with earlier findings for physiotherapy management post lumbar discectomy.[30 63] There is limited scope at present for good quality meta-analyses in physiotherapy with rigorous and well reported trial inclusion. Physiotherapy trials need to avoid risk of bias. Planning for quality is important, particularly for issues that present known problems for physiotherapy trials, for example loss to follow up. Consensus for minimum core sets of outcome measures for specific populations is also required.

Conclusions

This systematic review has identified inconclusive very low / low quality evidence for the effectiveness of physiotherapy management for Whiplash Associated Disorder II. Inclusion of large numbers of participants in the poorly designed trials published to date is unethical. Best practice for physiotherapy management, therefore, remains unclear. This lack of clarity might explain the variability of

interventions across the trials that made comparability of interventions difficult. There is potential benefit for improving pain and ROM flex/ext, Rot, and SF short term through active physiotherapy and for improving pain through specific physiotherapy interventions. This potential benefit merits further consideration in a properly powered clinical trial with attention to ensure low risk of bias.

Funding

No funding was received to support this work.

References

1. Spitzer W, Skovron M, Salmi L et al. (1995) Scientific monograph of the Quebec task force on whiplash associated disorders: redefining 'whiplash' and its management. Spine 1995;20(8):1S-73S .

2. Holm LW, Carroll LJ, Cassidy JD et al. The burden and determinants of neck pain in Whiplash Associated Disorders after traffic collisions, results of the Bone and Joint Decade 2000-2010 Task Force on Neck pain and its Associated Disorders. Spine 2008;33(45):S52-S59.

3. The Swedish Society of Medicine and the Whiplash Commission Medical Task Force. Whiplash Injuries: Diagnosis and early management. European Spine Journal 2008;17(Suppl3):S359-S418.

4. Burton K. Treatment guidelines: is there a need? In: Proceedings of Whiplash conference 2003, Bath, England, 6-8th May. Bristol: Lyons Davidson Solicitors; 2003.

5. Barnsley L, Lord S, Bogduk N. Whiplash injury: clinical review. Pain 1994;58:283-307.

6. Scholten-Peeters GGM, Verhagen AP, Bekkering GE et al. Prognostic factors of whiplash-associated disorders: a systematic review of prospective cohort studies. Pain 2003;104:303e22.

7. Carroll LJ, Hurwitz EL, Cote P et al. Research priorities and methodological implications. The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and its Associated Disorders. Spine 2008;33(4S):S214-S220.

8. Kampner SJ, Rebbeck TJ, Maher CG et al. Course and prognostic factors of whiplash: a systematic review and analysis. Pain 2008;138:617-629.

9. Eck JC, Hodges SD, Humphreys SC. Whiplash: a review of a commonly misunderstood injury. The American Journal of Medicine 2001;110(8):651-6.

10. Galasko CSB, Murray P, Stephenson W. Incidence of whiplash-associated disorder. BC Med J 2002;44:237-40.

11. Field S, Treleaven J, Jull G. Standing balance: a comparison between idiopathic and whiplash-induced neck pain. Man Ther 2008;13(3):183e91.

12. Chien A, Sterling M. Sensory hypoaesthesia is a feature of chronic whiplash but not chronic idiopathic neck pain. Man Ther 2010;15(1):48e53.

13. Woodhouse A, Liljebäck P, Vasseljen O. Reduced head steadiness in whiplash compared with non-traumatic neck pain. J Rehabil Med 2010; 42(1):35e41.

14. Verhagen AP, Lewis M, Schellingerhout JM et al. Do whiplash patients differ from other patients with non-specific neck pain regarding pain, function or prognosis? Manual Therapy 2011;16:452-462.

15. Sterling M. A proposed new classification system for whiplash associated disorders—implications for assessment and management. Manual Therapy 2004;9:60–70.

16. Moore A, Jackson A, Jordan J et al. Clinical guidelines for the physiotherapy management of Whiplash Associated Disorder (WAD). Chartered Society of Physiotherapy, London, 2005.

17. Verhagen AP, Scholten-Peeters GGGM, van Wijngaarden S et al. Conservative treatments for whiplash. Cochrane Database of Systematic Reviews 2007, Issue 2. Art. No: CD003338. DOI: 10.1002/14651858.CD003338.pub3.

18. World Health Organisation. International Classification of Functioning, Disability and Health: ICF. Geneva, Switzerland: World Health Organisation, 2001.

19. Furlan A, Pennick V, Bombardier C et al, from the Editorial Board of the Cochrane Collaboration Back Review Group. Updated method guidelines for systematic reviews in the Cochrane Collaboration back review group. Spine 2009;34:1929-1941.

20. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

21. Moher D, Liberati A, Tetzlaff J et al, The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097 2009; doi:10.1371/journal.pmed1000097

22. Centre for Reviews and Dissemination [CRD]. Systematic reviews: CRD's guidance for undertaking reviews in healthcare, 3rd edition, CRD University of York, York Publishing Services Ltd, 2009.

23. Cohen J. A coefficient of agreement for nominal scales. Educational and Psychological Measurement 1960;20:37-46.

24. Higgins JPT, Deeks JJ (editors). Chapter 7: Selecting studies and collecting data. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

25. Machin D, Fayers PM. Randomized Clinical Trials: design, practice and reporting. Wiley-Blackwell. West Sussex. 2010.

26. Higgins JPT, Altman DG, Sterne JAC (editors). Chapter 8: Assessing risk of bias in included studies. In. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

27. Jüni P, Witschi A, Bloch R et al. The hazards of scoring the quality of clinical trials for meta-analysis. JAMA 1999;282(11):1054-1060.

28. Katrak P, Bialocerkowski AE, Massy-Westropp N et al. A systematic review of the content of critical appraisal tools. BMC Medical Research Methodology 2004;4:22

29. Olivio SA, Macedo LG, Gadotti IC et al. Scales to Assess the Quality of Randomized Controlled Trials: A Systematic Review. Physical Therapy 2008;88:156-175.

30. Rushton A, Calvert M, Wright C et al (2011 in press). Physiotherapy trials for the 21st century – time to raise the bar? Journal of the Royal Society of Medicine. DOI 10.1258/jrsm.2011.110109.

31. Green S, Higgins JPT (editors). Chapter 2: Preparing a Cochrane review. In Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

32. DerSimonian R, Laird N. Meta-analyses in clinical trials. Controlled Clinical Trials 1986;7:177-188.

33. Deeks JJ, Higgins JPT, Altman DG (editors). Chapter 9: Analyzing data and undertaking meta-analyses. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

34. Hedges LV, Olkin I. Statistical methods for meta-analyses. Academic Press Inc. San Diego, 1985.

35. Hansson EE, Mansson NO, Ringsberg KAM et al. Dizziness among patients with whiplash-associated disorder: a randomised controlled trial, Journal of Rehabilitative Medicine. 2006;38:387-390.

36. Sterling M, Pedler A, Chan C et al. Cervical lateral glide increases nociceptive flexion reflex threshold but not pressure or thermal pain thresholds in chronic whiplash associated disorders: a pilot randomised controlled trial. Manual Therapy 2010;15:149-153.

37. Sterne JAC, Egger M, Moher D on behalf of the Cochrane Bias Methods Group. Chapter 10: Addressing reporting biases. In. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

38. Aigner N, Fialka C, Radda C et al. Adjuvant laser acupuncture in the treatment of whiplash injuries: a prospective, randomized placebo-controlled trial, Weiner Klinische Wochenschrift, The Middle European Journal of Medicine 2006;118(3/4):95-99.

39. Dehner C, Elbel M, Strobel P et al (2009). Grade II whiplash injuries to the neck: what is the benefit for patients treated by different physical therapy modalities? Patient Safety in Surgery 3(2).

40. Gonzalez-Inglesias J, Fernandez-de-las-Penas C, Cleland J et al. Short-term effects of cervical kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: a randomized clinical trial. Journal of Orthopaedic and Sports Physical Therapy 2009;39(7):515-521.

41. Jull G, Sterling M, Kenardy J et al. Does the presence of sensory hypersensitivity influence outcomes of physical rehabilitation for chronic whiplash? A preliminary RCT. Pain 2007;129:28-34.

42. Ask T, Strand LI, Skouen JS. The effect of two exercise regimes; motor control versus endurance / strength training for patients with whiplash-associated disorders: a randomized controlled pilot study. Clinical Rehabilitation 2009;23:812-823.

43. Bonk AD, Ferrari R, Giebel GD et al. Prospective, randomized, controlled study of activity versus collar, and the natural history for whiplash injury, in Germany. Journal of Musculoskeletal Pain 2000;8(1/2):123-132.

44. Pato U, Di Stefano G, Fravi N et al. Comparison of randomized treatments for late whiplash. Neurology 2010;74:1223-1230.

45. Scholten-Peeters GGM, Neeleman-van der Steen CWM, van der Windt DAWM et al. Education by general practitioners or education with exercises by physiotherapists for patients with whiplash-associated disorders? A randomized clinical trial. Spine 2006;31(7):723-731.

46. Stewart MJ, Maher CG, Refshauge KM et al. Randomized controlled trial of exercise for chronic whiplash-associated disorders, Pain 2007;128:59-68.

47. Thuile C, Walzl M. Evaluation of electromagnetic fields in the treatment of pain in patients with lumbar radiculopathy or the whiplash syndrome. Neurorehabilitation 2002;17:63-67.

48. Vassiliou T, Kaluza G, Putzke C et al. Physical therapy and active exercises – an adequate treatment for prevention of late whiplash syndrome? Randomized controlled trial in 200 patients. Pain 2006;124:69-76.

49. Vikne J, Oedegaard A, Laerum E et al. A randomized study of new sling exercise treatment vs traditional physiotherapy for patients with chronic whiplash-associated disorders with unsettled compensation claims. Journal Rehabilitation Medicine 2007;39:252-259.

50. Armstrong BS, McNair PJ, Williams M. Head and neck position sense in whiplash patients and healthy individuals and the effect of the cranio-cervical flexion action, Clinical Biomechanics 2005;20:675-684.

51. Fernandez-de-las-Penas C, Fernandez-Carnero J, Fernandez AP et al. Dorsal manipulation in whiplash injury treatment: a randomised controlled trial, Journal of Whiplash and Related Disorders 2004a;3(2):55-72.

52. Fernandez-de-las-Penas C, Fernandez-Carnero J, Palomeque del Cerro L et al. Manipulative treatment vs conventional physiotherapy treatment in whiplash injury: a randomised controlled trial, Journal of Whiplash and Related Disorders 2004b;3(2):73-90.

53. Rosenfeld M, Seferiadis A, Carlsson J et al. Active intervention in patients with whiplash associated disorders improves long term prognosis. Spine 2003;28(22):2491-2498.

54. Rosenfeld M, Seferiadis A, Gunnarsson R. Active involvement and intervention in patients exposed to whiplash trauma in automobile crashes reduces costs. Spine 2006;31(16):1799-1804.

55. Schnabel M, Ferrari R, Vassiliou T et al. Randomised, controlled outcome study of active mobilisation compared with collar therapy for whiplash injury. Emergency Medicine Journal 2004;21:306-310.

56. Soderlund A, Olerud C, Lindberg P. Acute whiplash-associated disorders (WAD): the effects of early mobilization and prognostic factors in long-term symptomatology. Clinical Rehabilitation 2000;14:457-467.

57. Soderlund A, Lindberg P. Cognitive behavioural components in physiotherapy management of chronic whiplash associated disorders (WAD) – a randomised group study. Physiotherapy Theory and Practice 2001;17:229-238.

58. Soderlund A, Lindberg P. Cognitive behavioural components in physiotherapy management of chronic whiplash associated disorders (WAD) – a randomised group study. Giornale Italiano di Medicina del Lavoro ed Ergonomia 2007;29(1): A5-A11.

59. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159-174.

60. Scholten-Peeters GGM, Verhagen AP, Neeleman-van der Steen CWM et al. Randomized clinical trial of conservative treatment with whiplash-associated disorders: considerations for the design and dynamic treatment protocol. Journal of Manipulative and Physiological Therapeutics 2003;26(7):412-420.

61. Stewart MJ, Maher CG, Refshauge KM et al. Advice or exercise for chronic whiplash-associated disorders? Design of a randomized controlled trial, BMC Musculoskeletal Disorders 2007;4:18.

62. Balshem H, Helfand M, Schunemann HJ et al. GRADE guidelines: 3. Rating the quality of evidence. Journal of Clinical Epidemiology 2011;64:401-406.

63. Rushton A, Wright C, Goodwin P et al. Physiotherapy rehabilitation post first lumbar discectomy: a systematic review and meta-analysis of Randomised Controlled Trials, Spine 2011;36(14):E961-72.

Table 3: Characteristics of eligible RCTs of physiotherapy management post whiplash injury

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
Physiotherapy management Whiplash Associated Disorder (WAD) II						
Aigner et al (2006) Austria Acute	RCT Two groups: A: Laser acupuncture with cervical collar B: Placebo laser with cervical collar Recruitment strategy unclear.	Acute whiplash injury, Kramer grade II (evaluated as equivalent to WAD II), aged 18-65 years with no recent traumatic bone injury cervical region, massive neurological symptoms, recent bone lesions, trauma > 4 days previously, or minor injury who were largely asymptomatic with cervical mobility free in all planes. Baseline (within 4 days of injury): n=50 (8 men, 42 women) A: n=25 B: n=25	***Intervention:*** Both groups: cervical collar for wearing first 1-2 weeks including at night if required (maximum duration 4 weeks), muscle relaxant combined with analgesic. Intervention A or B commenced at first follow up visit and not immediately post baseline. A: Helium Neon laser on 22 traditional needling acupuncture points for 15 seconds each (0.075J/cm^2), for a maximum of 3 times each week for 3 weeks. Duration intervention – mean of 4.6 visits (2-9). B: Externally identical laser device (red lamp) on same acupuncture points and same duration and number of treatments. Duration intervention – mean of 4.5 visits (2-10). ***Setting:*** Unclear	***Short term:*** ROM total flex/ext (cm measure), rotation, and side-flexion (goniometer). ***Long term:*** Duration of condition, neck pain, headaches, dizziness, wearing collar, drug use. Recurrence of myofascial pain, headaches, dizziness. ***Assessments:*** Short term at end of treatment (2-6 weeks post injury) (unclear in article) Long term by postal questionnaire at 8-12 months post injury.	No statistically significant advantage of A for any outcome. No results reported. Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: N=5 (10%) - 2 from A & 3 from B No exclusions No management of losses described Co-interventions not explored No ITT analyses reported
Dehner et al (2009) Germany Acute *Note: Comparison to patients in*	RCT Two groups: A: Active physical therapy B: Passive physical therapy	Acute whiplash injury, < 24 hours post injury, QTF II injury, with no previous injury cervical spine, muscular, neurological or mental disorders, osseous injury, or with no deficit in ROM. Baseline: 1 week post injury.	***Intervention*** ***Both groups:*** NSAIDS and soft cervical collar for 7 days. Post 7 days of collar and medication, patients commenced a standardised programme (A or B) three times per week for seven weeks. A: Soft tissue, trigger point, joint	***Short term (2 months):*** Pain score VAS (100mm): mean of "average degree of pain" and "most severe pain" Deficit in ROM of cervical spine: sum of individual ROM in 6 directions (flex/ext/side-flexion/ rotation) subtracted from pre-	Group A statistically significant greater decrease (p=.009) in median pain score at 2 months	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up:

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
a previous study excluded from extraction from trial report	Recruitment in emergency department.	n=70 patients A: n=35 (n=32 after exclusions due to loss-to follow-up); 10 male, 22 female. B: n=35 (n=32 after exclusions due to loss-to follow-up); 12 male, 20 female.	mobilisation (excluding cervical spine) techniques, posture training, and electrotherapy. Progressed to include: coordination training, training of the trunk and extremities, and stabilisation techniques with short segmental leverage (week 3); three-dimensional training with the head's weight as the limit of resistance (week 6); joint mobilisation cervical spine (week 8). B: Moist heat, classic massage and electrotherapy. ***Setting:*** Physical therapy department	defined normal value (330 degrees). Measured by goniometer. ***Short term (3-6 months):*** Period of disability: days off work Sickness costs: Costs of physical therapy and patient's lost income. ***Assessments:*** Short term: 2 months post injury By telephone after 3-6 months.	No significant inter-group differences on deficit ROM (p=.65) Confusing section on statistical methods – apparently reporting use of Wilcoxon signed ranks tests for inter-group comparisons Authors did not respond to request for data.	No drop outs Exclusions: n=3 from each group (9%) did not complete interventions No management of losses described Co-interventions not explored No ITT analyses. reported
Gonzalez-Inglesias et al (2009) Spain Acute / sub-acute	RCT Two groups: A: Kinesio Taping to the cervical spine (with tension) B: Sham Kinesio Taping (without tension) Recruitment of patients referred by a primary care physician to physiotherapy	Acute injury (within 40 days of injury), QTF II, neck pain and musculoskeletal signs, no evidence of conduction loss on clinical neurological examination, concussion during accident, treatment for neck pain prior to accident, previous whiplash, neck pain, headaches, psychiatric or psychologic condition, another somatic condition (e.g. fibromyalgia), current claim for litigation or compensation. Baseline: 72 hours post recruitment, within 40 days of injury. n=41 patients	***Intervention*** Both groups: No analgesia or anti-inflammatory medication prior to study. Interventions A and B implemented 1 day post baseline. A: Waterproof porous adhesive Kinesio Taping, width 5cm, thickness 0.5mm. Standardised therapeutic application to apply tension to the posterior cervical structures. Taping applied in positions of LSF, RSF and flex. B: Kinesio Taping similarly to group A but under no tension with neck positioned in neutral. ***Setting:***	***Short term*** Neck pain: NPRS CROM goniometric evaluation of flexion, extension, left side flexion, right side flexion, left rotation and right rotation, measured in degrees. ***Assessments:*** Short term: Immediately after taping 24 hours post intervention (unclear in article)	Group A statistically significant greater decrease in mean neck pain at immediate (p<.001) and 24 hour (p<.001) follow-ups. Group A statistically significant greater improvement in all ranges of movement at immediate and 24 hour follow-	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation No loss to follow up Co-interventions not explored No ITT analyses reported

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
		A: n=21 10 male, 11 female Age: mean 33 years (SD =6) Mean(SD) days post accident: 22 (SD=9) B: n=20 10 male, 10 female Age: mean 32 years (SD 7) Mean(SD) days post accident: 24 (SD 8)	Unclear		ups (p<.001 in all tests). Authors no longer possess data.	
Jull et al (2007) Australia Chronic	RCT Two groups: A: Multimodal physiotherapy programme B: Self-management programme Recruitment by referral from General Practitioner or general advert in popular press. Stratification for presence or not of widespread mechanical or cold hyperalgesia.	Chronic whiplash resulting from road traffic accident, WADII, aged 18-65, persistent problems 3 months to 2 years post injury, and no WADIII, WADIV, previous neck pain, previous road traffic accident, not fluent in English, or currently receiving physical therapy. Baseline: n=71. 3 months – 2 years post injury. A: n=36, 63% female Age: mean 41 years (SD 12) Months since injury: mean 13.3 (SD 6.0) B: n=35, 80.6% female Age : mean 38 years (SD 10) Months since injury: mean 12.0 (SD 7.4)	A: Multimodal programme delivered by a physiotherapist. Intervention of 10 weeks and 10-15 treatments, respecting chronicity. Low load to avoid provocation. Included exercises to: re-educate muscle control of the neck and scapular, posture, functional activities, retraining kinaesthetic sense. Included low velocity mobilisation techniques, education and assurance, advice to continue exercise at home. B: Information about whiplash and advice to stay active and exercise documented in a booklet, that included: education about the mechanism of WAD, assurance re recovery, advice to stay active, ergonomic advice re ADL, advice re an exercise programme. The advice and exercise programme were similar to that provided to group A. Encouraged to perform exercises twice per day. **Setting:** Unclear	***Short term:*** Neck pain and disability: NPI (primary outcome). ROM cervical spine: 3D Fastrac device. Cervical muscle test: CCFT Psychological tests: GHQ-28 IES TAMPA Participants perceptions: Benefit of treatment VAS Gaining of relief VAS ***Assessment:*** Short term immediately post treatment.	Significantly greater reduction mean NPI in group A (p=.04); greater improvement in mean muscle function CCFT in group A (p<.018), but, significantly lower mean change on TSK in group A (p=.02). No significant differences between groups in mean ROM gain (all p>.35), mean change on GHQ-28 (p=.28), or mean change on IES p=.15). Authors provided data.	Primary outcome measure specified Primary endpoint specified *A priori* power calculation conducted on NPI (alpha =.05; power = 90%) Loss to follow up: Drop outs: 2/35 lost to follow up in group B No exclusions No management of losses described ITT analyses performed
Sterling et al	RCT	Chronic WADII. Aged 18-65	A: Three sets of one-minute cervical lateral	***Short term:***	Significantly	*A priori* specification of primary

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
(2010) Australia Chronic	Two groups: A: Cervical spine manual therapy technique (lateral glide). B: Manual contact control intervention. Recruitment by general advertisement and from a University Clinic database.	years, reporting neck pain from a road traffic accident >3months previously, with no WADIII, WADIV, or unable to speak and write English. Baseline: n=39 participants. > 3 months post injury A: n=22. 14 females. Age years: mean 41 (SD 14) B: n=17. 13 females. Age years: mean 39.1 (SD 13.2)	glide spine manual therapy away from the nominated side of pain, with a one minute rest between sets. Patient positioned in supine and treatment at C5-6 level. Pain free technique. B: Hand placement and positioning as for group A, but with no neck movement. Pain free for the participant. Setting: Unclear	PPT: hand held algometer (Somedic), evaluations at cervical spine, median nerve, and Tibialis Anterior sites. TPT: Thermotest system evaluating hot and cold pain thresholds at C5-6 spinous processes. NFR threshold and VAS pain measured at right sural nerve. *Assessment:* Short term immediately post treatment.	greater increase in mean NFR threshold in group A (p=.04). No significant difference between interventions for NFR pain rating (p=.063), PPT cervical spine (p=.78), PPT median nerve (p=.068), PPT Tibialis Anterior (p=.49), and TPT heat (p=.55) or cold (p=.48). Data not requested from authors as no comparable outcomes to other trials.	outcome measure assumed owing to power calculation Primary endpoint specified *A priori* power calculation conducted on NFR threshold (alpha = .05; power = 80%) No loss to follow up for sensory measures. Loss to follow up for NFR: A: n=3 (14%) B: n=2 (12%) NFR could not be elicited. No management of losses for NFR described No ITT analysis reported
Physiotherapy management Whiplash Associated Disorder (WAD) I/II						
Ask et al (2009) Norway Sub acute	RCT Two groups: A: Motor control exercises. B: Endurance and strength training exercises Recruitment by consecutive	Sub-acute (> 6 weeks and < 3 months) whiplash injury from car collision, symptoms within 48 hours of injury, WADI or WAD II, NDI ≥10, aged 18-67 years with no cervical fracture or dislocation, neurological deficit, head injury or concussion related to the injury, serious mental disease, inflammatory rheumatic disease, prior cervical surgery, alcohol or drug abuse,	***Intervention:*** Both groups: to maintain usual activities and avoid using a soft collar. Both interventions 1:1 physiotherapy, with 1-2 sessions per week, over 6 weeks, with a minimum of 6 & maximum of 10 sessions. Each session lasted approximately 30 minutes. Both groups encouraged to perform daily home exercises and to participate in common activities. Exercise programmes were adjusted if pain were exacerbated during the intervention	***Short term:*** ***Primary outcome:*** NDI (0-50). ***Secondary outcomes:*** VAS Pain (100mm) morning and evening. Pain drawing (1-120). Passive flexibility as part of the	No statistically significant difference between groups for any outcome. On NDI (primary outcome): p=.912 at short -term and p=.783 at long-term assessments. Authors did not	Primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: (same at 6 weeks and 1 year): A: n=2 (1 other illness) B: n=3 (no time for treatment)

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	recruitment from Emergency department. After 4 weeks patients contacted to see if symptoms were persisting and if so, to invite to baseline assessment.	pregnancy, or insufficient knowledge of Norwegian language. WADII: No separation of data for WADI and WADII. Baseline (6 weeks post injury): n=25 Stratification: for age and gender. Group A: n=11 Group B: n=14	period. A: Motor control exercises. Motor relearning programme. Initial focus on coordination/holding neck flexor/extensor and shoulder girdle muscles, at low load and pain free x 10 reps; using pressure biofeedback. Mean of 8.0 treatments. B: Endurance and strength training exercises. 5 minute warm up. Higher load to recruit deep and superficial flexor and extensor muscles, using rubber band; upper body strengthening; 15-20 reps with no discomfort. 5 minute stretching. Mean of 8.4 treatments. ***Setting:*** Outpatient spine clinic.	GPE-52 (scale 0-9.2): shoulder retraction, lumbo-sacral, head nod, head rotation. Number of tender points (max 18). Isometric endurance neck flexors and extensors. CROM (Myrin goniometer / compass) flex/ext, rotation, side flexion. ***Long term:*** As short term; plus: PGIC (7 point scale) Satisfaction with care (5 point scale) Co-interventions Work status ***Assessments:*** Short term at 6 weeks after start of intervention (12 weeks post injury). Long term at 1 year post randomisation (58 weeks post injury).	respond to request for data.	No exclusions Management of losses: Missing data imputed - median or mean group difference from baseline to 6 weeks and from baseline to 58 weeks. Co-interventions not explored ITT analyses performed Per protocol analyses also performed.
Bonk et al (2000) Germany	RCT 2 groups: A: Active therapy.	Acute WAD I or II, aged 16-60 years with no: prior neurological disease, prior neck injury, x-rays showing old fractures or skeletal	Both groups could use analgesics, anti-inflammatories A: No collar. Active therapy with	***Short term:*** Neck pain prevalence (%) Neck stiffness prevalence (%)	No statistically significant differences between groups on any outcome	No primary outcome measure specified No primary endpoint specified

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
Acute	B: Collar therapy. Control group of healthy subjects to assess background prevalence of symptoms. n=25 female and 25 male. Mean age 25.8(5.8) years. Recruitment of consecutive rear end collisions presenting to emergency department.	malformations, spondyloarthropathy, symptom onset > 3 days post injury, WADIII or WADIV. WADII: No separation of data for WADI and WADII. Baseline: Within 3 days of injury. A: n=53 n=47 analysed. 19 female, 28 male age mean 26.7 (SD 7.7) years B: n=50 26 female, 24 male age mean 28.7 (SD 9.1) years	physiotherapist. 3 sessions in week 1, 2 sessions in weeks 2 and 3. Ice to neck muscles for 10 minutes, passive mobilisation of neck in supine, active mobilisation neck , strengthening and isometric exercises. Supine week 1, sitting week 2. Week 3 – interscapular muscle strengthening exercises, advice re posture. B: Collar therapy. Wearing a collar for 3 weeks during day. No physiotherapy, activity, exercises or mobilisation. ***Setting:*** Unclear	Headache prevalence (%) Shoulder pain prevalence (%) Arm pain prevalence (%) Neck ROM flex/ext cm Neck ROM side flexion goniometer (degrees). Neck ROM rotation goniometer (degrees). ***Assessments:*** Short term: Reported at 6 weeks Reported at 12 weeks	at 6 or 12 weeks follow-up. Authors did not respond to request for data.	No *a priori* power calculation Loss to follow up: No drop outs Exclusions: A: 1 developed neurological symptoms, n=5 non-compliant with therapy (11%). n=47 analysed. No management of losses described Co-interventions not explored No ITT analyses reported
Pato et al (2010) Switzerland Chronic WAD	RCT 3 groups: A: Local anaesthetic infiltration. B: Physiotherapy. C: Medication. Followed by randomization to CBT or no CBT in each group (1:1). Recruitment of	WADI or II, due to hyperflexion or hyperextension injury, symptoms > 6 months, < 12 months post injury, with no fracture / dislocation, injuries to other areas of the body from the accident, head trauma, loss of consciousness, post traumatic amnesia, head injury, previous brain injury, previous neurological deficit, previous whiplash, pre-existing neck pain, or previous neck surgery. WADII: No separation of data for	8 week treatment period A: Local anaesthetic infiltration tender points (evoked by palpation / movement) in neck. No injection given in a session if no painful or tend point found. Up to 16 sessions per patient. B: Massage, learned relaxation techniques of myogelotic muscles, programme of isometric and low intensity isotonic training neck muscles, continued as home exercises. 2 sessions per week. C: 200mg flurbiprophen (slow release) once per session. Patients seen twice a week by study physician.	**Primary outcome measures:** Subjective outcome rating (4 categories: worse/ unchanged / improved /resolved) Pain McGill Pain VAS (0-10 scale). Working capacity (% determined by physician) Secondary outcome measures: HAQ Well Being Scale (Zerssen)	No statistically significant difference in efficacy between the 3 interventions. CBT had a significant effect but only in women, for pain. Results reported for n values of: A: 27 B: 23 C: 23 No CBT: 33 CBT: 40. Authors did not	*A priori* specification of primary outcome measure assumed owing to power calculation No primary endpoint specified *A priori* power calculation conducted on pain intensity (alpha = 0.05; power 0.8; effect size 0.6). Loss to follow up: Drop outs: Losses of 16% reported. A: n=3 discontinued, 2 did not tolerate intervention, 1 on

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	participants identified through Swiss Accident Insurance Fund and Swiss Insurance Association registers. All patients meeting criteria referred to a coordinator. Stratification: Gender, age and education .	WADI and WADII. Baseline: 6-12 months post injury. A: n=30 67% women age mean 38 (SD 11) randomised to: CBT n=16 No CBT n=14 B: n=29 57% women age mean 40(SD 12) randomised to: CBT n=14 No CBT n=15 C: n=28 61% women age mean 43(SD 13) randomised to: CBT n=14 No CBT n=14	CBT: 2 sessions per week by psychologist (16 sessions), 60 mins per session. Followed a therapy manual provided to participants. Aimed to teach control of pain through control of physical reaction to stress and chronic pain management techniques. No CBT: No additional management. Setting: Unclear	CFQ to evaluate cognitive ability **Assessments:** Short term: Immediately after treatment period 3 months later. 6 months later.	respond to request for data.	lawyer's advice (n=27 in analysis, 16 with CBT and 11 without) B: n=6 discontinued, 2 dissatisfied with intervention, 3 study too long, 1 moved away (n=23 in analysis, 13 with CBT and 10 without) C: n=5 discontinued, 3 dissatisfied with intervention, 1 on lawyer's advice, 1 study too long (n=23 in analysis, 11 with CBT and 12 without) No exclusions No management of losses reported Co-interventions not explored No ITT analyses reported
Scholten-Peeters et al (2006) Netherlands Sub-acute	RCT 2 groups: A: GP care B: Physiotherapy Recruitment from 122 GP practices and 3 emergency departments. Eligibility checked at 2 weeks post injury.	Acute WAD I or II as a result of a road traffic accident, with symptoms (neck pain/headache/dizziness) within 48 hours injury, living in Netherlands, aged 18-55, with no: cervical hernia, past cervical spondylodesis, loss of consciousness, history of previous neck or head injury in past 3 years, insufficient knowledge of Dutch language, or co-morbidities. No separation of data for WADI and WADII.	**Both interventions:** Both interventions were delivered according to a dynamic biopsychosocial treatment protocol using treatment goals and corresponding interventions. Patient centred. Treatment commenced 4 weeks post injury. Maximum duration interventions 9 months. No limit to number of sessions. Treatment ended when problem was resolved or treatment goals achieved, or when plateau of improvement reached. A: 10 minute sessions with GP. Education and advice on graded activity, dependent	**Primary outcome measures (short and long term):** Neck pain VAS (0-100) Headache intensity VAS (0-100) Work activities in daily living VAS (0-100) ***Secondary outcome measures:*** Functional recovery VAS General Health Status SF36 (0-100)	No statistically significant difference between groups for primary outcomes of neck pain or headache intensity at 12 or 52 weeks, or work activities at 12 weeks (adjusted and unadjusted for baseline characteristics).	Trial protocol published with *a priori* specification *A priori* specification of primary outcome measures assumed owing to power calculation No primary endpoint specified *A priori* power calculation conducted on pain and work activities VAS (alpha = 0.05; power 0.8; difference of 20%). Loss to follow up:

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	Stratification for: general practice / emergency department, region of Netherlands (middle/south).	Baseline: 4 weeks post injury. A: n=42 Mean age (SD) 33.8(10.3) 61.9% women B: n=38 Mean age (SD) 31.9(9.0) 71.1% women *Note:* *High initial pain intensity and work disability compared to other studies.*	upon treatment goals. Reassurance, remain active, and resume activity as soon as possible, and expected prognosis. Emphasis that withdrawal from activity, soft collar use and reliance on medication may delay recovery. Decreased focus on pain and encouraged patient to take responsibility. Mean no of treatment sessions 3.9(2.9), mean treatment episode at 18.8(15.2) weeks. B: 30 minute sessions with physiotherapist. Education, advice, graded activity, as for GP. Graded activities with supervision, motivation, reassurance. Exercise – progressive loading cervical and shoulder muscles, active movements, posture and balance. Function – carrying, lifting, pushing and cycling using graded progression. Manual techniques as indicated, but not first choice of treatment. Mean no of treatment sessions 12.7(12.1), mean treatment episode at 19.9(13.5) weeks. Setting: Unclear	ROM cervical spine (degrees): flex/ext, side flexion, rotation, total ROM. Fear of movement Tampa (17-68) Coping PCI Disability NDI (0-50) Disability in housekeeping and social activities VAS (0-100) ***Assessments:*** Short term: 8 weeks post injury. 12 weeks post injury. 26 weeks post injury Long term: 52 weeks post injury. 52 week follow up by questionnaire only.	Group A significantly better than B for work activities (unadjusted for baseline characteristics) at 52 weeks. Some statistically significant differences on secondary outcomes but inconsistent across unadjusted and adjusted analyses Authors did not respond to request for data.	Drop outs: At 12 weeks (4%): A: n=1 loss of motivation, n=1 recovered B: n=1 not satisfied with treatment Loss to follow up greater for secondary outcome measures. No exclusions Management of losses: Missing values imputed using group means/medians Co-interventions: Received co-interventions at 12 weeks (7%): A: n=6 B: n=0 Received co-interventions at 52 weeks (15%): A: n=12 B: n=4 ITT analyses performed Per protocol analyses also performed
Stewart et al (2007) [Stewart et al (2003)] Australia Chronic	RCT 2 groups A: Exercise and advice B: Advice alone Recruitment by	Patients presenting for medical care of WAD I-III within one month of injury, reporting at least mild disability, score at least 20% on pain or disability primary outcome measure; with no: previous neck surgery, known or suspected serious pathology, nerve root	Both groups received advice based on the baseline assessment prior to randomisation. A: 6 week graded exercise programme under supervision by physiotherapist (12 sessions), including 1 hour exercise – 30 mins supervised by physiotherapist. Individualised, progressive, sub-maximal programme designed to enable	***Primary outcome measures*** Pain intensity VAS (0-10) over previous 24 hours. Pain bothersomeness VAS (0-10) over previous 24 hours. Functional ability using PSFS (0-10).	Statistically significant improvement in mean pain (p=.005), bothersomeness (p=.019) and PSFS (p=.006) in group A at 6 weeks. No	No primary outcome measure specified (multiple measures specified) No primary endpoint specified *A priori* power calculation conducted on VAS pain intensity and pain bothersomeness and NDI (alpha = 0.05; power 80%)

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	letters to claimants who experienced a whiplash injury 3-12 months earlier	compromise (WAD III), contraindication to exercise, severe depressive symptoms (DASS), neck radiograph since accident, current physiotherapy treatment, poor use of English. No separation data WAD I II or III. Authors confirmed only WAD I and II participants. Baseline: 3-12 months post injury. N=134 randomised. A: n=66 Age (years) mean (SD) 43.9 (15.1) Gender female n (%) 48 (73%) B: n=68 Age (years) mean (SD) 42.7 (14.4) Gender female n (%) 41 (62%)	completion of functional activities specified by the participant as difficult owing to whiplash, including: aerobic exercise, stretches, functional activities, focus to build speed, endurance and coordination, trunk and limb strengthening exercises, principles of CBT, goal setting, self monitoring of progress, self reinforcement, encouragement to continue as home programme. Mean number of sessions 9.9 (range 0-12). B: Standardised education, reassurance and encouragement for resuming light activity alone, emphasis on positive prognosis, addressing common inaccurate beliefs re whiplash, physical activity positive to recovery, excessive voluntary limitation of activity being problematic, checking understanding and beliefs of whiplash; including written summary of main points. One consultation and two follow-up phone calls (2 and 4 weeks) by physiotherapist. Mean number of sessions 2.9 (range 1-3). ***Setting:*** Two physiotherapy clinics	***Secondary outcome measures*** Disability using NDI (0-50). GPE 11 point scale (-5 to 5) Health related quality of life using physical and mental summary scores of SF36. Work status Adverse effects of treatment using open questions. Perception of credibility of intervention using a questionnaire at 6 weeks only. Compliance with activity programme using exercise diaries and attendance register at 6 weeks only. ***Assessments:*** Short term: 6 weeks post baseline (not explicitly stated) Long term: 12 months	statistically significant differences at 12 months. Statistically significant improvement in mean NDI (p=.004), SF36 physical (p=.003), SF36 Mental (p=.005) and GPE (p=.006) in group A at 6 weeks. No statistically significant differences at 12 months. Authors provided data.	with no adjustment for alpha spend Loss to follow up: Drop outs: A: total losses 3 (4.5%) B: total losses 6 (8.8%) A: No loss to follow up at 6 weeks B: 2 lost to follow up at 6 weeks A: 3 lost to follow up at 12 months B: 4 further lost to follow up at 12 months Management of losses: Missing data were imputed using appropriate mean item score (for that participant) Participants were omitted from analyses if all follow up data were missing. Co-interventions: Co-interventions by 6 weeks: A: n=10 (15%) B: n=15 (23%). Co-interventions by 12 months: A: n=18 (29%) B: n=35 (56%) ITT analyses performed
Thuile and Walzl (2002)	RCT 2 groups:	Kramer whiplash grades I and II, with pain (neck pain, post head pain, shoulder / arm	A: Standard medication with diclofenac and tizanidine. With magnetic field system 'Vitalife MRS 2000' at intensity 50%	Pain VAS (0-10) for head, neck and shoulder/arm areas.	Statistically significant lower pain in head,	No primary outcome measure specified

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
Austria Acute (? Unclear)	A: Standard medication with magnetic therapy. B: Standard medication. Recruitment of patients reporting for treatment.	pain, stiffness neck), loss of mobility in three directions. WADII: No separation of data for WADI and WADII. Baseline: Unclear A: n=44 21 men, 23 women Mean (SD) age 37.2(17.8) B: n=48 31 men, 17 women Mean (SD) age 44.8(22.6)	(10,000 nano Tesla) for first 2 days, then 100% (20,000 nano Tesla) for two subsequent days, then 150% (30,000 nano Tesla) for a further 10 days. MRS cushion for 16 minutes and whole body mat for 8 minutes. Polarity switched every 2 minutes. B: Control of standard medication with diclofenac and tizanidine. ***Setting:*** Clinic for neurology and psychiatry, although not explicitly stated.	ROM in three planes (degrees): Flex/ext Rotation Side flexion No detail of measurement tool. ***Assessments:*** Short term – unclear	neck and shoulder/arm for A (p<.003). Statistically significant higher ROM in all three planes for A (p<.05). Authors did not respond to request for data.	No primary endpoint specified No *a priori* power calculation Loss to follow up: No data reported on loss to follow up No management of losses described. Co-interventions not explored No ITT analyses reported
Vassiliou et al (2006) Germany Acute	RCT 2 groups: A: Physical therapy B: Standard treatment Recruitment by presentation to trauma department one hospital within 48 hours of injury.	WAD I and II, within 48 hours of injury, aged 18-70 years, with no: history of chronic or recurrent pain within previous 6 months, additional accident related injury, diseases or contraindications to treatment procedures, living > 50km away, pregnant, or further accident / surgery head, neck or thorax during trial, patients treatment by physiotherapists other than those in the trial, patients with modified treatments due to new findings and diagnoses. WADII: No separation of data for WADI and WADII. Baseline: Within 48 hours of	A: Physical therapy 10 sessions within the first 14 days post injury. Heat to neck for 5 minutes, lymph drainage for 10 minutes, massage for 10 minutes, active exercises with elastic resistance to neck and shoulder for 10 minutes. Home exercises for 20 minutes each day. In addition to medication (diclofenac and ranitidine). Use of soft collar allowed as demanded by patient for first 2 days post injury. B: Standard treatment of soft collar continuously worn for first 7 days in addition to medication (diclofenac and ranitidine). Then no specific treatment. ***Setting:*** Unclear	***Primary outcomes*** Pain intensity NRS (0-10) Disability intensity NRS (0-10) ***Secondary outcomes*** Days with oral medication. Period of immobilisation with soft collar. Localisation of injury-associated pain disorder (marked on a dermatomal map) Resolution of pain. ***Assessments:*** Short term:	Statistically significant lower pain (p=.002) and disability (p=.002) for group A at 6 weeks, and at 6 months (p<.001 for pain and for disability). Used 1 tailed test for primary outcomes. Authors did not respond to request for data.	Primary outcome measures specified No primary endpoint specified *A priori* power calculation conducted on pain intensity and disability (alpha 0.05; power 0.9; anticipated 30% benefit) Loss to follow up: Drop outs: 1 week post baseline: A: n=7 B: n=14 6 weeks post baseline: A: n=15 (15%) B: n=35 (36%) 6 months post baseline: A: n=31 (30%) B: n=45 (46%) No exclusions Management of losses:

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
		injury. Mean time interval between injury and enrolment 8.5(9.3) hours. A: n=103 Age mean(SD) 30.1(10.3) 62.1% female B: n = 97 Age mean(SD) 28.3(8.9) 60.8% female		1 week post baseline 6 weeks post baseline 6 months post baseline		Missing values imputed using last value carried forward. Co-interventions not explored ITT analyses performed Per protocol analyses also reported Consistent findings for per protocol analysis
Vikne et al (2007) Norway Chronic	RCT 4 groups: A: Traditional physiotherapy with no home training B: Traditional physiotherapy with home training C: Sling exercise therapy with no home training D: Sling exercise therapy with home training Recruitment through insurance company. All patients with ongoing claims.	Patients aged 18-60 who have experienced a traffic accident 6-12 months previously, WADI or II, with no: ongoing treatment, pregnancy, alcohol or drug abuse, serious illness, language difficulties. WADII: No separation of data for WADI and WADII. Baseline: 6-12 months post injury. 43.9% scored as 'psychiatric cases' on the HSCL. A: n=53 B: n=55 C: n= 51 D: n= 54	Home programmes started after 3 weeks in all groups. A: Traditional physiotherapy with usual exercises focused to strength and endurance training of the neck, back and abdominal muscles. Using patient's body weight as resistance, patient manuals, and fixed training devices. Passive modalities including electrotherapy, massage, manipulation and acupuncture as required but emphasis on active treatment. Training stopped at 4 months. Contacted by physiotherapist by telephone and encouraged to train every fourth month for 12 months. Plus home training programme based on exercises covered in traditional physiotherapy sessions. B: As above but home training programme continued to 12 months, and changed once a month. C: Protocol of 10 graded exercises using ceiling mounted sling with patient sitting and supine to mobilise and strengthen. Combined with traditional physiotherapy intervention. 24 sessions over 4 months.	Complaints on a scale (1-9) Pain neck/shoulder past 14 days VAS Modified RMDQ Sick leave Psychological distress using Hopkins Symptom Checklist (HSCL) 25 item reporting previous week. Cervical ROM: Flexion, extension, left rotation, right rotation in degrees. Neck stabilisation/endurance hold in seconds. Cervico kinaesthetic sensibility – relocation from rotation. ***Assessments:*** Short term: 4 months post baseline	No statistically significant differences between groups (p=.07 to .82) except for small effect for home training on pain during rest (p=.05) and reported fatigue (p=.02). Pooling AB v CD small effect (p=.01) on neck endurance for AB. Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: At 4 and 12 months (1 drop out prior to intervention): A: n=6, n=5(21%) B: n=5, n=5 (18%) C: n=6, n=5 (22%) D: n=4, n=6 (19%) (Some reasons provided. 1/3 not related to treatment) 20% drop outs overall (10% at 4 months) Exclusions: N=6 excluded owing to incomplete adherence, and unclear whether exclusions are included as part of drop out figures.

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
			Training stopped at 4 months. Contacted by physiotherapist by telephone and encouraged to train every fourth month for 12 months. Plus home training programme using ceiling mounted sling at home. D: As above but home training programme continued to 12 months, and changed once a month. ***Setting:*** Institute	Long term: 12 months post baseline		No management of losses described Co-interventions not explored No ITT analyses reported
Physiotherapy management Whiplash Associated Disorder (WAD) II/III						
Armstrong et al (2005) New Zealand Chronic *Study involved two cohorts of whiplash and healthy control patients. Whiplash only cohort reported here. Design not followed through to make any comparisons on outcomes for A and B.*	RCT 4 groups: A: Cranio-cervical stability exercises B: Control Recruitment by local newspaper advertisement	Patients with minimum of 1 whiplash injury, > 3 months previously, < 5 years previously, WAD II/III; with no therapy at time of study, previous history of head injury, spinal fracture/dislocation, spinal surgery, systemic inflammatory disorders, neurological disorders, Meniere's Disease, disabling vertigo, medication for vertigo, inner ear damage, large metallic implants. No separation data for WAD II and III. A: n=? unclear B: n=? unclear	A: Cranio-cervical action in sitting as a stabilizing exercise of the cervical spine, combined with scapular stabilising. 4/5 practices with simultaneous performance of head and neck joint position tasks, with and without a blindfold. B: Rest in a lightened room for 15 reading a magazine. ***Setting:*** Unclear	Head and neck position sense (Fastrak) ***Assessments:*** Short term: Immediately post treatment	Design not followed through to make any comparisons on outcomes for A and B. No statistical tests reported on whiplash participants only. Authors did not respond to request for data.	No primary outcome measure specified Primary endpoint specified No *a priori* power calculation No reporting of loss to follow up No management of losses described No comparative analysis reported No ITT analyses reported
Fernandez-	RCT	Participants with a history of	Both groups – conventional physiotherapy	VAS (1-100mm) neck pain, dorsal	Statistically	No primary outcome measure

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
de-las-Penas et al (2004a) Spain Acute / subacute Study involved two cohorts of whiplash and mechanical neck pain patients. Whiplash only cohort reported	2 groups: A: Dorsal manipulation technique and conventional physiotherapy treatment. B: Control of conventional physiotherapy treatment. Recruitment through a private clinic for physical therapy and osteopathy. N=88 volunteers from and initial sample of n=120 were recruited.	whiplash injury WAD II / III, for 3 weeks to 3 months; with no prior whiplash injury, articular instability (fracture, luxation), degenerative cervical alteration. No separation data for WAD II and III. A: n=44 B: n=44	treatment – consisting of active exercises at home, electrotherapy, ultrasound therapy, muscle stretching, multimodal therapy, and manual therapy. 15 sessions of treatment. A: Dorsal manipulation at 5th and 10th treatment sessions. HVLA 'Dog' technique. Single technique with cavitation, and conventional physiotherapy. B: Conventional physiotherapy treatment only. **Setting:** Private clinic for physical therapy and osteopathy, although not explicitly stated.	region pain, and head pain. ***Assessments:*** Short term: After 10 treatment sessions (one week after dorsal manipulation at 5th treatment session). After 15 treatment sessions) one week after dorsal manipulation at 10th treatment session).	significant mean reduction in neck pain for group A (p=.002) after 15 treatment sessions. Statistically significant mean reduction in dorsal pain for group A after 10 (p=.001) and 15 (p=.001) treatment sessions. No statistically significant change in mean head pain (p>.20) Authors no longer possess data.	specified No primary endpoint specified No *a priori* power calculation Loss to follow up: No apparent losses but not explicitly reported. Co-interventions not explored No ITT analyses reported
Fernandez-de-las-Penas (2004b) Spain Acute	RCT 2 groups A: Manipulative protocol. B: Control of conventional physiotherapy Recruitment from a private clinic for manual therapy	Acute whiplash injury < 3 months duration, WAD II / III, for < 3 months; with no prior whiplash injury, previous cervical surgery, having manipulative or manual therapy within past month, or articular instability (fracture, luxation). Baseline: A: n=190 Females n=50	A: Manipulative protocol including high velocity low amplitude techniques, soft tissue mobilisation techniques and mobilisation techniques. Weekly manipulative treatment. Mean of 9 (SD 1.5) sessions. B: Conventional physiotherapy treatment – consisting of active exercises at home, electrotherapy, ultrasound therapy, muscle stretching, multimodal therapy, and manual therapy. 15 sessions of treatment. Daily physiotherapy treatments. Mean of 23 (SD 3.2) sessions.	VAS head and neck pain (0-100mm). Cervical active range of movement (CROM) flexion and rotation using a goniometer. Number of sessions needed to complete treatments ***Assessments:*** Short term:	No comparison of outcome measures at same time interval post baseline. Comparison for whole treatment packages A and B possible at end of treatment. No results	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: No apparent losses but not explicitly reported. Co-interventions not explored No ITT analyses reported

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	and physiotherapy	Age mean (SD) 27 (7) WAD II n=155 WAD III n=35 B: n=190 Females n= 30 Age mean (SD) 28 (7) WAD II n=150 WAD III n=40	***Setting:*** Private clinic for manual therapy and physiotherapy, although not explicitly stated.	A: after each 4 sessions (i.e. monthly). B: after each 10 sessions (i.e. 2 weeks). Apparent assessment at end of treatment reported in Tables and Figures.	reported for comparison of whole treatment packages, except for number of sessions to complete treatment that was significantly lower for A (p=.002). Authors no longer possess data.	
Hansson et al (2006) Sweden Chronic	RCT 2 groups A: Vestibular rehabilitation programme. B: Control, no intervention. Recruitment from general practitioners and physiotherapists in primary healthcare, orthopaedic physicians in private practice, administrators of rehabilitation at a regional social insurance office, and an	Patients with WAD with reported dizziness. WAD II / III. Baseline: Median 1year post injury (6 months to 15 years) A: n=16 n=16 WAD II, n= 0 WAD III Duration dizziness median (range): 2(0-8) Females n= 10 Age: median 40 (range 22-73) years B: n=13 n=12 WAD II, n= 1 WAD III Duration dizziness median (range): 2(0-15) Females n= 10 Age: median 43 (range 23-76)	A: Vestibular rehabilitation programme of group sessions. 50 minutes twice a week for 6 weeks. Consisting of 10 minute warm up, exercises to stimulate vestibular system using eye, head and trunk movements, progressing to closed eyes. B: Control. No intervention. **Setting:** Physiotherapy centre	4 balance measures 1] Tandem standing with eyes open then closed for 30 seconds each; mean of both legs (seconds). 2] SOLEO: standing on one leg, eyes open (SOLEC closed eyes); mean of both legs (seconds). 3] Walking in a Figure of 8 with steps outside of the figure counted (steps). 4] Walking line. Walking heel to toe on a 5m line, with steps outside the line counted (steps). 5) DHI: 3 dimensions: functional, emotional and physical. ***Assessments:*** Short term:	Statistically significant higher median SOLEO for group A at 6 weeks (p=.02) and 3 months (p<.0005). Statistically significant longer median tandem standing (closed) for group A at 6 weeks (p=.045). Statistically significant lower median DHI for group A at 6 weeks on total (p=.047), functional (p=.005) and physical (p=.033); and at 3 months	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: 11 drop outs (38.0%) (3 other sickness, 3 lack of time, 1 could not tolerate treatment, 4 reason unknown) A: n=8 B: n=3 No exclusions Management of losses: Last observation carried forward. Co-interventions not explored ITT analyses performed

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	orthopaedic hospital clinic.			6 weeks post baseline 3 months post baseline	on physical (p=.04). Data not requested from authors as no comparable outcomes to other trials.	Per-protocol analyses also performed
Physiotherapy management Whiplash Associated Disorder (WAD) 0/I/II						
Rosenfeld et al (2003) Rosenfeld et al (2006) (reporting same trial) Sweden Acute	RCT 4 groups: A: Active intervention within 96 hours injury. B: Standard intervention within 96 hours injury C: Active intervention 14 days post injury D: Standard intervention 14 days post injury. Recruitment of consecutive patients assessed in 29 primary care units, 3 emergency wards and several private clinics.	Individuals exposed to whiplash trauma in motor vehicle collisions, seeking healthcare. Trauma caused by rapid movement of the head resulting in acceleration forces. WAD 0 I or II, with no: neurological deficit WADIII or fracture / dislocation WADIV, head injury, previous symptomatic chronic neck problem, alcohol abuse, dementia, serious mental disease, or diseases that could lead to death before study completion. WADII: No separation of data for WAD 0, I and II. Of the n=97/102 who received allocated intervention, n=4 were classified as WADO at baseline. Baseline: Within 96 hour of injury.	No intervention during delay period for groups C and D. A and C: Active intervention – active exercise protocol of early and repeated movements consistent with McKenzie principles. Two phases 1] information, postural control, cervical rotation exercises, home exercises, exercises within limits of pain, in sitting if tolerated; 2] if symptoms unresolved 20 days post injury, evaluation and treatment according to McKenzie principles. Treatment for 6 weeks unless symptoms resolved earlier. Mean number of treatments 3.95. B and D: Standard intervention – written information on injury, advice re activity, postural correction. Rest in first weeks with soft collar for comfort and limiting excessive movements. Active movement 2/3 times per day a “few weeks” after injury. **Setting:** Unclear	***Short term:*** Pain VAS: combined head, neck, shoulder region CROM lateral flexion (degrees) C ROM rotation (degrees) CROM flexion/extension (degrees) Duration sick leave in previous 6 moths Any additional interventions received. ***Long term:*** As above but with no evaluation of additional interventions. ***Assessments:*** Short term at 6months. Long term at 3 years.	Statistically significant greater reduction on pain intensity in groups A and C at 6 months (p=.0004) and 3 years follow-up (p=.020). Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Drop outs: 21% overall 8% at 6 month follow up: A: 1 refused participation B: n=3 refused participation C: n=1 not contactable, n=1 moved abroad D: n=1 refused participation, n=1 not needed Further drop outs at 3 year follow up (13%): A: n=1 no time, n=2 not contactable B: n=1 travelling, n=1 not contactable C: n=1 no time, n=1 travelling, n=1 not contactable, n=1 re-injury D: n=1 refused, n=3 not contactable

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
		AT 3 year follow up, subjects matched to a comparison group for gender and age. A: n=25 B: n=26 C: n=26 D: n=25 Baseline data for all participants randomised not provided.				Exclusions: 11% participants excluded at 6 months. n=5 patients excluded post randomisation A: n=3 (not meet inclusion(2), re-injury(1)) B: n=0 C: n=2 (not meet inclusion) D: n=1 (not meet inclusion) Further participants excluded at 3 years (8%): A: n=3 (not meeting inclusion(2),re-injury(1)) B: n=0 C: n=2 (not meeting inclusion) D: n=3 (not meeting inclusion(1) re-injury(2)) Exclusions 19% overall. No management of losses described Co-interventions: Numbers of participants receiving interventions outside of study within 6 months: A: n=3 B: n=9 C: n=5 D: n=9 ITT analyses performed
Schnabel et al (2004) Germany Acute	RCT 2 groups: A: Collar B: Physiotherapy Recruitment of	Motor vehicle accident causing at least one of pain, stiffness or numbness in spine, head or limbs, within 48 hours of injury, ≥ 18 years old, with no: WADIII or IV, loss of consciousness, fracture, or pregnant.	Both groups: Diclofenac 50mg 3 x daily. Requested to not undertake other therapies. A: Collar for 1 week day and night, no advice re sleeping, posture. B:	***Short term*** Symptom prevalence: neck pain, headache, shoulder pain, back pain, limb pain, limb paraesthesia, visual disturbance, tinnitus, dizziness. Average total pain VAS (0-10)	Group B had statistically significant lower prevalence of neck pain(p= .025), headache (p=.028), shoulder pain (p=.008), and	No primary outcome measure specified Primary endpoint specified *A priori* power calculation conducted on unknown outcome measure (alpha 0.05; power 0.9; on 30% benefit)

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
	consecutive patients presenting to trauma department	WADII: No separation of data for WADI and WADII. Baseline: 48 hours post injury. A: n=97 Mean age(SD) 28(9) 61% female B: n=103 Mean age(SD) 30(10) 62% female	Physiotherapy exercises for mobilisation. 2-5 visits in the first week dependent upon needs. ***Setting:*** Unclear	Degree of disability VAS (0-10) ***Assessments:*** Short term: 6 weeks post baseline	unresolved symptoms (p=.010) Group B had statistically significant lower mean pain (p=.047) and mean disability (p=.042). Authors no longer possess data.	Loss to follow up: Drop outs: A: 36% B: 15%. No exclusions No management of losses described Co-interventions not explored No ITT analyses reported
Physiotherapy management Whiplash Associated Disorder (WAD) I/II/III						
Soderlund et al (2000) Sweden Acute	RCT 2 groups: A: Regular treatment group. B: Additional exercise group Recruitment of all patients visiting emergency department with notable symptoms when visiting the orthopaedic clinic	Acute whiplash injury with report of acceleration-deceleration movement of the head but without direct trauma, WAD I-III. Aged 18-60 years, with good understanding of Swedish; and no previous neck injury. Mean of 20 days post injury. 35 women and 24 men. n=66. 14% (n=8) were WAD I. 83% (n=49) were WAD II. 3% (n=2) were WAD III. A: n=32. B: n=34. Baseline: mean of 20 days post injury.	A: Exercise programme of alternating rest with exercises, keeping the neck warm, walking daily, maintaining an upright posture when sitting, standing and walking, not lifting or carrying heavy objects, and, not to sit with head flexed forward during first few weeks post injury. Patients were instructed to restore normal neck movements as soon as possible including: cervical rotation, flexion shoulders, deep breath with shoulder girdle elevation. All exercises were performed cautiously, within pain limits, at least three times a day. Patients were advised not to use a collar unless needing to travel by car, read, or study for long periods. B: As above, complemented by exercises for improving kinaesthetic sensibility and coordination of neck muscles, three times a day. ***Setting:***	PDI generic and domain specific disability related to chronic pain. Score 0-70. SES completion of daily living despite pain. Score 0-200. CSQ extent of using cognitive or behavioural coping strategies. Cervicocephalic kinaesthetic sensibility, right and left relocation from rotation. VAS pain intensity (0-10). Compliance with exercises using daily exercise diaries. Cervico-thoracic posture using universal goniometer. CROM right and left rotation using goniometer.	No statistically significant differences between groups on any outcome. Authors did not respond to request for data.	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: Losses of n=6 (18.7%) group A and n=7 (20.6%) group B. Drop outs: A: n=3 drop outs at 3 month follow up. B: n= 4 drop outs at 3 month follow up. Exclusions: A: n=3 excluded owing to insufficient data at 3 month follow up. B: n= 3 excluded owing to insufficient data at 3 month follow up.

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
			Unclear	***Assessments:*** Short term: 3 months (unclear whether post baseline or intervention) 6 months (unclear whether post baseline or intervention)		No management of losses described Co-interventions not explored No ITT analyses reported
Soderlund and Lindberg (2001) Soderlund and Lindberg (2007) Sweden Chronic	RCT 2 groups: A: Experimental B: Comparison Recruitment from Orthopaedic clinic of patients with significant symptoms presenting to a 3 month follow up appointment	Patients with continuous symptoms 3 months after a whiplash injury with reports of an acceleration – deceleration movement of the head, but without direct head trauma. WAD I – III. Aged 18-60 years, good ability to understand Swedish. No separation data for WAD I II or III. Baseline: after 3 month follow up appointment in clinic. n=33. A: n=16. Female n=9 mean age 38 years B: n=17. Female n=10 mean age 44 years	A: Individualised four phases of treatment 1] learning of basic physical and psychological skills 2] application and 3] generalisation of skills into general everyday activities 4] maintenance of these skills. Using a functional behaviour analysis approach, and treatment goal setting. Aiming to change problem behaviours and recognise the factors that perpetuate muscular dysfunction. Included techniques of relaxation, re-education posture, muscle stabilisation, mobilisation exercises, and re-education of humeroscapular rhythm. B: Individualised exercises to enhance muscular stabilisation of neck, neck and shoulder mobility with stretching and coordination of head movement, and exercise to maintain body posture and arm muscle strength. Exercises carried out at physiotherapy department and at home. Treatment could also include: pain relieving methods of relaxation, TENS, acupuncture, heat etc. Both interventions with a physiotherapist, maximum of 12 treatment sessions. ***Setting:***	PDI generic and domain specific disability related to chronic pain; 0-70. NRS pain intensity (0-10). Cervico-thoracic posture using universal goniometer. CROM degrees using goniometer. Cervicocephalic kinaesthetic sensibility, right and left relocation from rotation . Patient perception of treatment result 4 questions (only at immediate post treatment follow up) Patient perception of treatment result 7 questions (only at 3 month follow-up). ***Assessments:*** Short term: Immediate post treatment	Statistically significant lower patient perception of pain for group A immediately post treatment (p<.05), significantly better patient perceived ability in group A to perform daily activities at 3 months (p<.05); and significantly better long-term compliance in group A to manage / prevent neck pain at 3 months (p<.05) Treatment integrity was measured. Results not reported on CSQ	No primary outcome measure specified No primary endpoint specified No *a priori* power calculation Loss to follow up: No drop outs Exclusions: B: n=1 did not comply with treatment No management of losses described Co-interventions not explored No ITT analyses reported

Study	Design	Participants & indication	Intervention & setting	Outcome measures	Main results	Analysis / comments
			A: Patient's home. B: Physiotherapy department gym & home	3 months follow up	and SES to compare patients with high and low self efficacy. Authors did not respond to request for data.	

Footnote: ADL = Activities of Daily Living; CBT = Cognitive Behavioural Therapy; CCFT = Cranio-Cervical Flexion Test; CFQ = Cognitive Failures Questionnaire; CI = Confidence Interval; CROM = Cervical Range of Motion; CSQ = Coping Strategies Questionnaire; ext = extension; DASS = Depression Anxiety Stress Scale; DHI = Dizziness Handicap Inventory; flex = flexion; GHQ-28 = General Health Questionnaire 28; GPE = Global Perceived Effect; HAQ = Health Assessment Questionnaire; IES = Impact of Events Scale; ITT = Intention to Treat; L = left; LR = Left Rotation; LSF = Left Side Flexion; McGill = McGill Pain Questionnaire; NDI = Neck Disability Index; NFR = Nociceptive Flexion Reflex; NPI = Northwick Park Neck Pain Index; NPRS = Numerical Pain Rating Scale (11 point scale); NRS = Numerical Rating Scale; NSAID = Non-Steroidal Anti-inflammatory agent; PCI = Patient Coping Inventory; PDI = Pain Disability Index; PGIC = Patients' Global Impression of Change; PPT = Pressure Pain Threshold; PSFS = Patient Specific Functional Scale; QTF – Quebec Task Force; R = right; RCT = Randomised Controlled Trial; reps = repetitions; ROM = Range of Motion; RR = Right Rotation; RSF =Right Side Flexion; RMDQ = Roland Morris Disability Questionnaire; SD = standard deviation; SES = Self Efficacy Scale; SF-36 = Short Form 36 Health Survey; TPT = Thermal Pain Threshold; TSK = TAMPA Scale of Kinesophobia; TENS = transcutaneous electrical nerve stimulation; VAS = Visual Analogue Scale; WAD = Whiplash Associated Disorders.

Figure 1: Study selection flow diagram (from Moher et al[20])

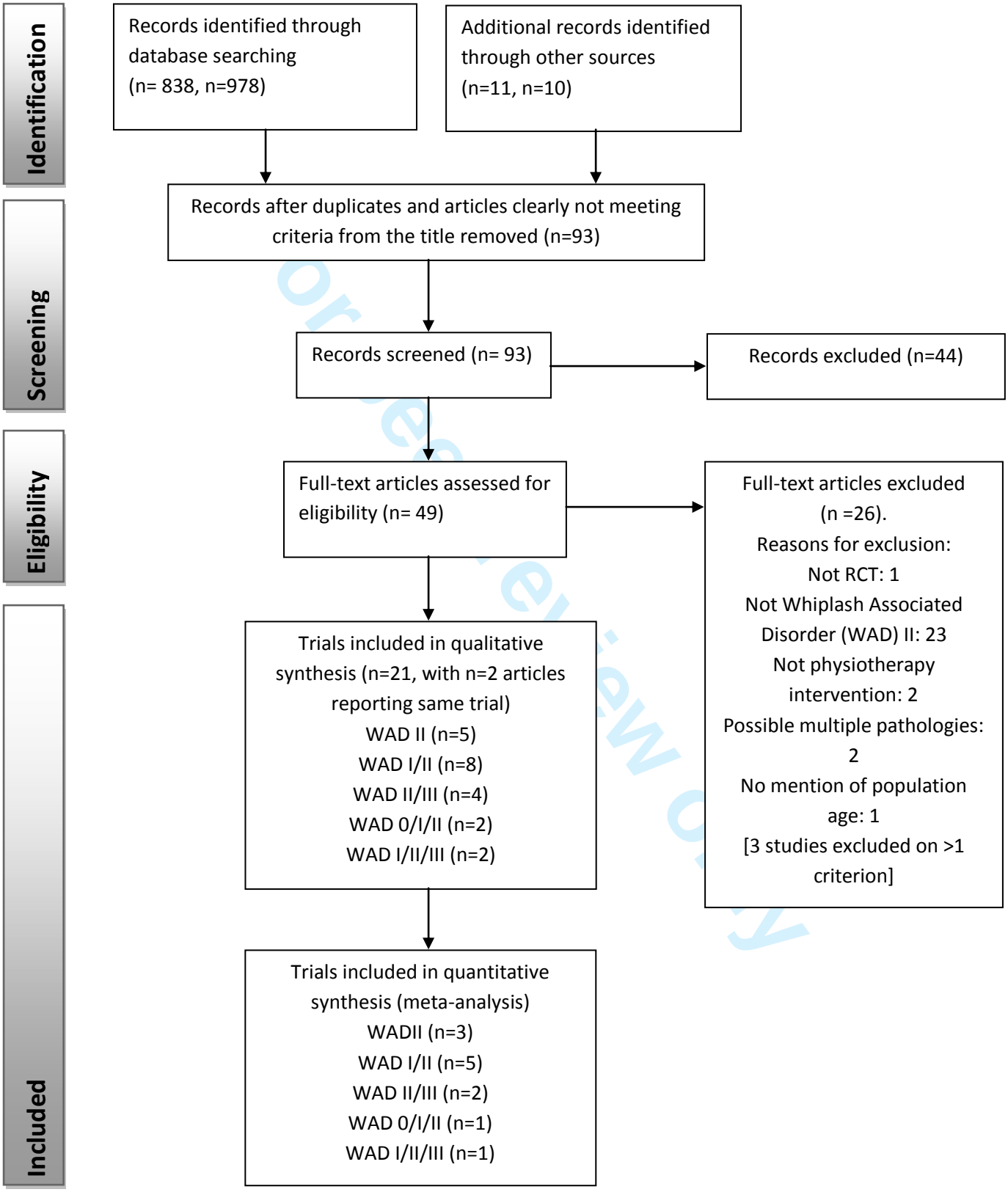
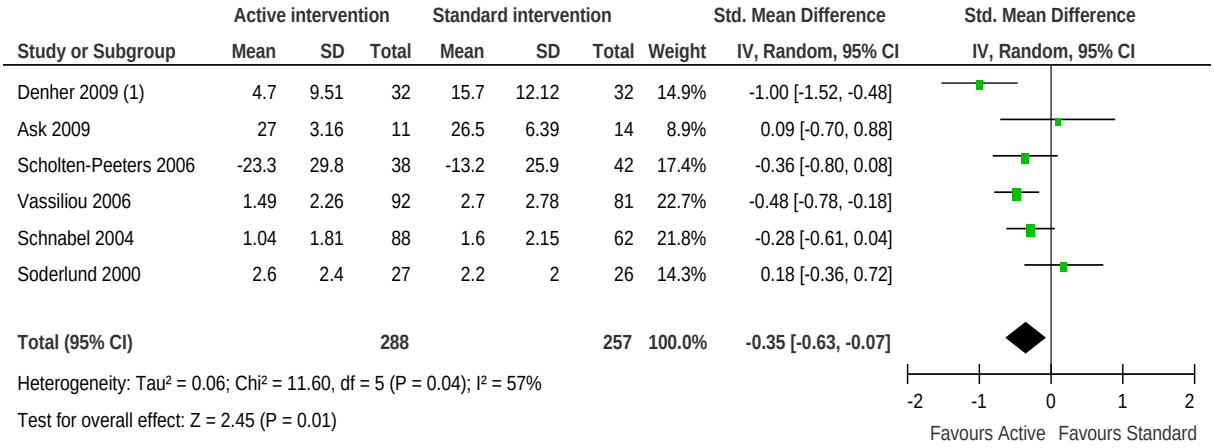


Figure 2 Pain short-term



(1) Scholten-Peeters reported change in pain

Figure 3 ROM Flexion/Extension short-term

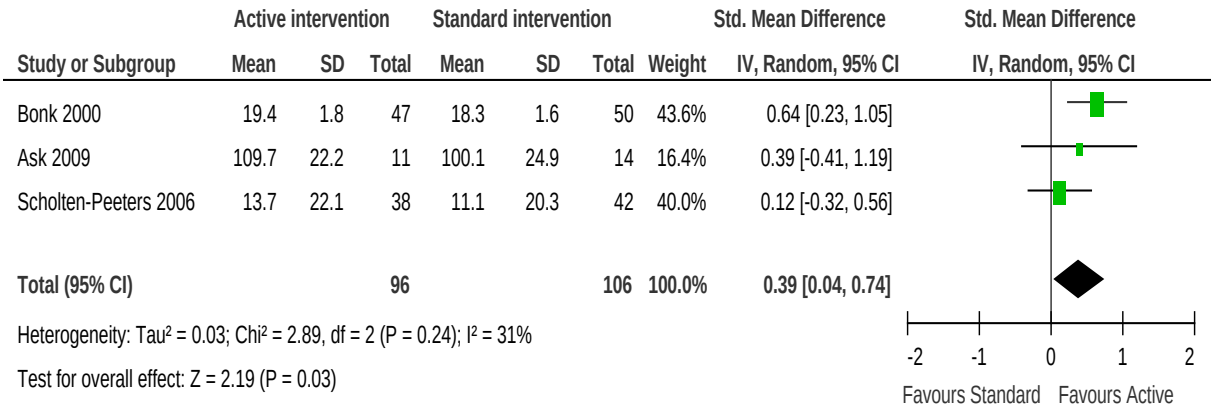


Figure 4 ROM RSF/LSF short-term

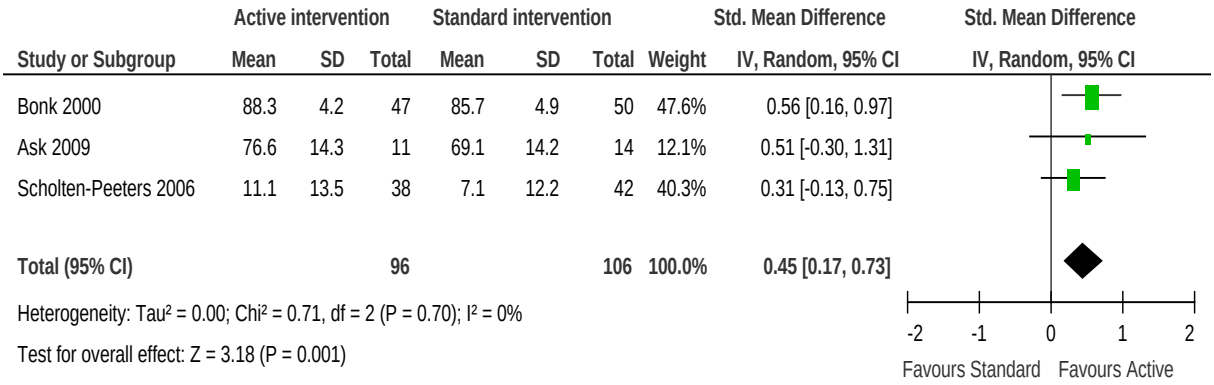


Figure 5 ROM Rotation R/L short-term

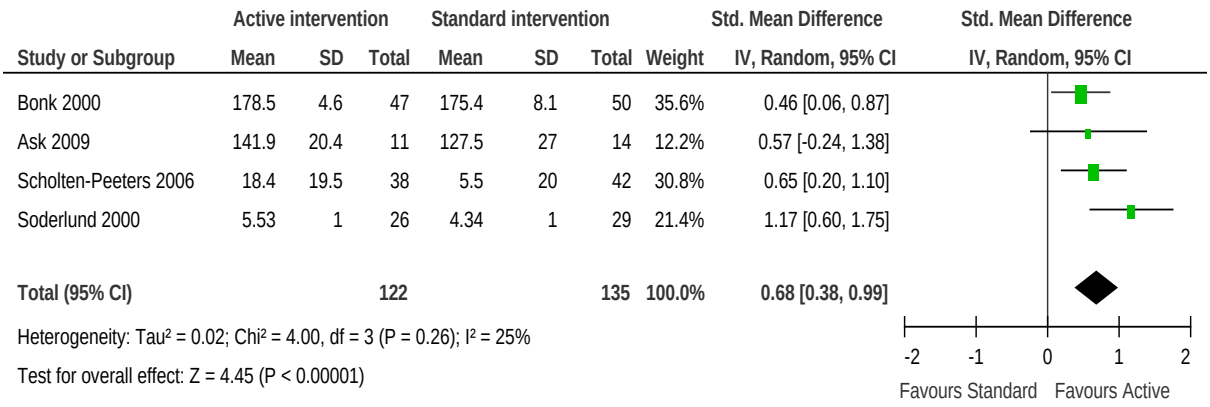


Figure 6 Disability short-term

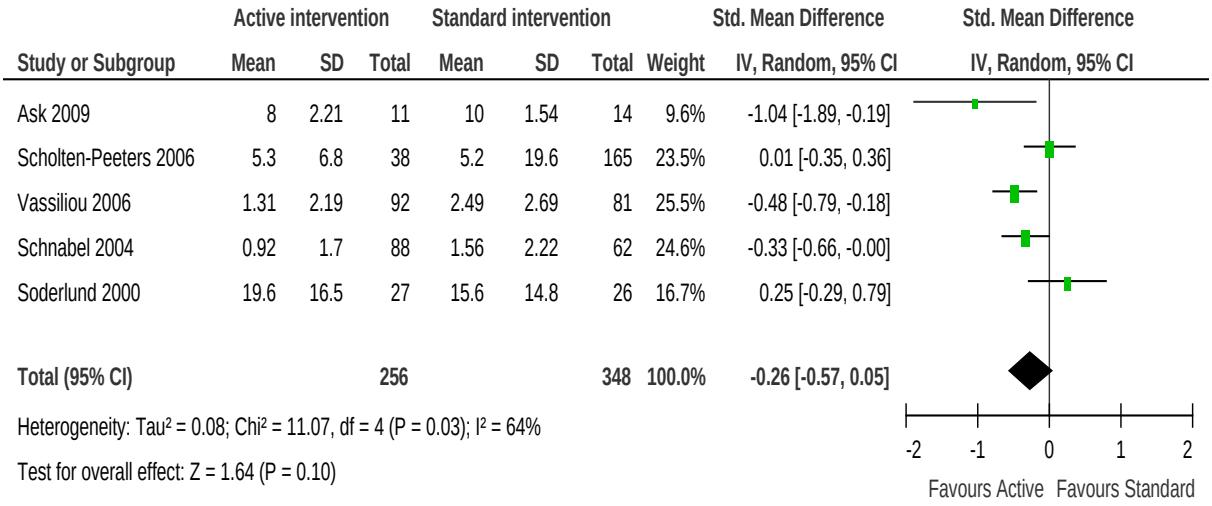


Table 1 Checklist of items to include when reporting a systematic review or meta-analysis

Section/topic	Item No	Checklist item	Reported on page No
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both	2
Abstract			
Structured summary	2	Provide a structured summary including, as applicable, background, objectives, data sources, study eligibility criteria, participants, interventions, study appraisal and synthesis methods, results, limitations, conclusions and implications of key findings, systematic review registration number	4-5
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known	7-8
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS)	8
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (such as web address), and, if available, provide registration information including registration number	9
Eligibility criteria	6	Specify study characteristics (such as PICOS, length of follow-up) and report characteristics (such as years considered, language, publication status) used as criteria for eligibility, giving rationale	9
Information sources	7	Describe all information sources (such as databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched	9-10
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated	10
Study selection	9	State the process for selecting studies (that is,	10

		screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis)	
Data collection process	10	Describe method of data extraction from reports (such as piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators	11
Data items	11	List and define all variables for which data were sought (such as PICOS, funding sources) and any assumptions and simplifications made	11
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis	11-12
Summary measures	13	State the principal summary measures (such as risk ratio, difference in means).	12
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (such as I^2 statistic) for each meta-analysis	12-13
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (such as publication bias, selective reporting within studies)	13
Additional analyses	16	Describe methods of additional analyses (such as sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified	13
Results			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram	13
Study characteristics	18	For each study, present characteristics for which data were extracted (such as study size, PICOS, follow-up period) and provide the citations	14-16
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see item 12).	16
Results of individual studies	20	For all outcomes considered (benefits or harms), present for each study (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot	17-18

Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency	17-18
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see item 15)	17
Additional analysis	23	Give results of additional analyses, if done (such as sensitivity or subgroup analyses, meta-regression) (see item 16)	n/a
Discussion			
Summary of evidence	24	Summarise the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (such as health care providers, users, and policy makers)	19-20
Limitations	25	Discuss limitations at study and outcome level (such as risk of bias), and at review level (such as incomplete retrieval of identified research, reporting bias)	20-21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research	21
Funding			
Funding	27	Describe sources of funding for the systematic review and other support (such as supply of data) and role of funders for the systematic review	21