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Harvey LA, Katalinic OM, Herbert RD, Moseley AM, Lannin NA, Schurr K

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[Intervention Review]

Stretch for the treatment and prevention of contractures

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ABSTRACT

Background

Contractures are a common complication of neurological and non-neurological conditions, and are characterised by a reduction in joint mobility. Stretch is widely used for the treatment and prevention of contractures. However, it is not clear whether stretch is effective. This review is an update of the original 2010 version of this review.

Objectives

The aim of this review was to determine the effects of stretch on contractures in people with, or at risk of developing, contractures.The outcomes of interest were joint mobility, quality of life, pain, activity limitations, participation restrictions, spasticity and adverse events.

Search methods

In November 2015 we searched CENTRAL, DARE, HTA; MEDLINE; Embase; CINAHL; SCI-EXPANDED; PEDro and trials registries.

Selection criteria

We included randomised controlled trials and controlled clinical trials of stretch applied for the purpose of treating or preventing contractures.

Data collection and analysis

Two review authors independently selected trials, extracted data, and assessed risk of bias. The outcomes of interest were joint mobility, quality of life, pain, activity limitations, participation restrictions and adverse events. We evaluated outcomes in the short term (up to one week after the last stretch) and in the long term (more than one week). We expressed effects as mean differences (MD) or standardised mean differences (SMD) with 95% confidence intervals (CI). We conducted meta-analyses with a random-effects model. We assessed the quality of the body of evidence for the main outcomes using GRADE.

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Main results

Forty-nine studies with 2135 participants met the inclusion criteria. No study performed stretch for more than seven months. Just over half the studies (51%) were at low risk of selection bias; all studies were at risk of detection bias for self reported outcomes such as pain and at risk of performance bias due to difficulty of blinding the intervention. However, most studies were at low risk of detection bias for objective outcomes including range of motion, and the majority of studies were free from attrition and selective reporting biases. The effect of these biases were unlikely to be important, given that there was little benefit with treatment. There was high-quality evidence that stretch did not have clinically important short-term effects on joint mobility in people with neurological conditions (MD 2°; 95% CI 0° to 3°; 26 studies with 699 participants) or non-neurological conditions (SMD 0.2, 95% CI 0 to 0.3, 19 studies with 925 participants).

In people with neurological conditions, it was uncertain whether stretch had clinically important short-term effects on pain (SMD 0.2; 95% CI -0.1 to 0.5; 5 studies with 174 participants) or activity limitations (SMD 0.2; 95% CI -0.1 to 0.5; 8 studies with 247 participants). No trials examined the short-term effects of stretch on quality of life or participation restrictions in people with neurological conditions. Five studies involving 145 participants reported eight adverse events including skin breakdown, bruising, blisters and pain but it was not possible to statistically analyse these data.

In people with non-neurological conditions, there was high-quality evidence that stretch did not have clinically important short-term effects on pain (SMD -0.2, 95% CI -0.4 to 0.1; 7 studies with 422 participants) and moderate-quality evidence that stretch did not have clinically important short-term effects on quality of life (SMD 0.3, 95% CI -0.1 to 0.7; 2 studies with 97 participants). The short-term effect of stretch on activity limitations (SMD 0.1; 95% CI -0.2 to 0.3; 5 studies with 356 participants) and participation restrictions were uncertain (SMD -0.2; 95% CI -0.6 to 0.1; 2 studies with 192 participants). Nine studies involving 635 participants reported 41 adverse events including numbness, pain, Raynauds' phenomenon, venous thrombosis, need for manipulation under anaesthesia, wound infections, haematoma, flexion deficits and swelling but it was not possible to statistically analyse these data.

Authors' conclusions

There was high-quality evidence that stretch did not have clinically important effects on joint mobility in people with or without neurological conditions if performed for less than seven months. Sensitivity analyses indicate results were robust in studies at risk of selection and detection biases in comparison to studies at low risk of bias. Sub-group analyses also suggest the effect of stretch is consistent in people with different types of neurological or non-neurological conditions. The effects of stretch performed for periods longer than seven months have not been investigated. There was moderate- and high-quality evidence that stretch did not have clinically important short-term effects on quality of life or pain in people with non-neurological conditions, respectively. The short-term effects of stretch on quality of life and pain in people with neurological conditions, and the short-term effects of stretch on activity limitations and participation restrictions for people with and without neurological conditions are uncertain.

PLAIN LANGUAGE SUMMARY

Is stretch effective for treating and preventing joint deformities?

Review question: we reviewed the evidence about the effect of stretch in people who had or were vulnerable to joint deformities.

Background: we wanted to know whether stretch interventions are effective for the treatment and prevention of joint deformities (also known as contractures) in people with neurological and non-neurological conditions. Some of the conditions contained in this review included people with fracture, stroke, brain injury, arthritis or burns.

Stretch can be administered with splints and positioning programmes, or with casts, which are changed at regular intervals (serial casts). Alternatively, stretch can be self-administered or applied manually by therapists.

Study characteristics: this Cochrane review is current to November 2015. It includes the results of 49 randomised controlled trials involving 2135 participants. The participants had a variety of neurological and non-neurological conditions including stroke, acquired brain injury and spinal cord injury, arthritis, wrist fracture and burns.

Studies compared stretch to no stretch, often delivered with standard care for the disorder or another co-intervention such as exercise or botulinum toxin injection in the case of spasticity.

The stretch was administered in a variety of different ways including through passive stretching (self-administered, therapist-administered and device-administered), positioning, splinting and serial casting.

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The stretch dosage was highly variable, ranging from five minutes to 24 hours per day (median 420 minutes, IQR 38 to 600) for between two days and seven months (median 35 days, IQR 23 to 84). The total cumulative time that stretch was administered ranged from 23 minutes to 1456 hours (median 168 hours, IQR 24 to 672).

The outcomes of interest were joint range of motion, spasticity, pain, ability to move, ability to participate in life, quality of life and adverse events. The short-term (less than one week) and long-term (more than one week) effects were investigated separately.

Study funding sources: no study was funded by a drug manufacturer or by an agency with a commercial interest in the results of the studies.

Key results: we found the following short-term effects up to one week after the last stretch intervention in studies that compared stretch with no stretch:

Joint Mobility (high score is better outcome)

Neurological conditions: stretch improves joint mobility by 1% (0% to 2% better) or 2° (0° to 3°)

Non-neurological conditions: stretch improves joint mobility by 1% (0% to 3% better)

Quality of life (high score is better outcome)

Neurological conditions: no studies

Non-neurological conditions: stretch improves quality of life by 1% (0% to 3% better)

Pain (low score is better outcome)

Neurological conditions: stretch increases pain by 2% (1% worse to 6% worse)

Non-neurological conditions: stretch decreases pain by 1% (3% better to 1% worse)

Activity limitation (high score is better outcome)

Neurological conditions: stretch improves the ability to move by 1% (0% to 2% better)

Non-neurological conditions: stretch improves the ability to move by 1% (2% worse to 4% better)

Participation (high score is better outcome)

Neurological conditions: no studies

Non-neurological conditions: stretch decreases engagement in participation with life by 12% (31% worse to 6% better)

Adverse events

Neurological and non-neurological conditions: 49 adverse events were reported, including skin breakdown, pain , numbness, venous thrombosis, wound infections, haematoma, flexion deficits and swelling . We could not calculate the risk of such events with stretch as a dverse events were not r eported in all studies , or not reported for both the treatment and control groups .

Quality of the evidence: there was high-quality evidence that stretch does not have clinically important short-term effects on joint mobility in people with neurological or non-neurological conditions. There was high quality evidence that stretch does not have clinically important short-term effects on pain, and moderate-quality evidence that stretch does not have clinically important short-term effects on quality of life in people with non-neurological conditions.

Conclusion: stretch is not effective for the treatment and prevention of contractures and does not have short-term effects on quality of life and pain in people with non-neurological conditions. The short-term and long-term effects of stretch on other outcomes in people with neurological and non-neurological conditions are not known.

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SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Short-term effects of stretch for the treatment and prevention of contractures

Patient or population: people with neurological conditions[1]
Settings: inpatients and outpatients
Intervention: short-term effects of stretch (< 1 week after the last stretch)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments, summary statistics, NNTB and absolute risk difference (ARD)
	Assumed risk	Corresponding risk				
	Control	Short-term effects of stretch				
Joint mobility Range of motion Scale from 0°-135° (higher number reflects better outcome)	Mean joint mobility in the control groups was **10°**[2]	The mean joint mobility in the intervention groups was **2° higher** (0° to 3° higher)		549 (18 studies)	⊕⊕⊕⊕ **high**[3]	Absolute change = 1% better (0% to 2% better) Relative change = 2% better (0% to 3% better) The results rule out a clinically important treatment effect equivalent to 5°
Quality of life	No studies measured quality of life		Not estimable	Not estimable	Not estimable	Not measured
Pain 10-point VAS (lower score reflects better outcome)	The mean pain in the control group was **0.6 points** on a 10-point VAS[4]	This translates to an absolute mean increase of 0.2 higher (-0.1 to 0.6) points compared with control group on a 10-point scale.[5]		174 (5 studies)	⊕⊕◯◯ **low**[3,6]	SMD = 0.2 higher (0.1 lower to 0.5 higher) Absolute change = 2% worse (1% better to 6% worse) Relative change = 55% worse (28% better to 138% worse)

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Activity limitations 18-point upper limb scale (higher score reflects better outcome)	The mean activity limitation in the control group was **0.9 points** on an 18-point upper limb scale[7]	This translates to an absolute mean increase of 0.1 (-0.1 to 0.3) points compared with control group on an 18-point scale[8]		237 (7 studies)	⊕⊕◯◯ **low**[3,9]	SMD = 0.2 higher (0.1 lower to 0.5 higher) Absolute change = 1% better (0% to 2% better) Relative change = 38% better (26% worse to 104% better)
Participation restrictions	1 study measured participation restrictions but it did not provide useable data	Not estimable	Not estimable	Not estimable	Not estimable	
Adverse events	Five studies involving 145 participants reported 8 adverse events that may have been related to the intervention. These included skin breakdown, bruising or blisters from plaster casts, and shoulder and wrist pain from stretches applied through positioning	Not estimable	Not estimable	Not estimable	Not estimable	

*The **assumed risk** (e.g. the mean control group risk across studies) is based on one representative study chosen on the basis of its size and susceptibility to bias. The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **NNTB**: number needed to treat for an additional beneficial outcome; **RR:** risk ratio; **SMD**: standardised mean difference; **VAS**: visual analogue scale

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] All the studies included in this review and included in the 'Summary of findings' outcomes included people with the following neurological conditions: stroke, Charcot-Marie-Tooth disease, acquired brain injury, spinal cord injury and cerebral palsy. The treatment effects were consistent across all types of neurological conditions except acquired brain injury (see Discussion).
[2] Post data of the control group in Refshauge 2006 (the corresponding data in Analysis 1.1 is not raw data).
[3] The quality of evidence was not downgraded due to risk of bias even though at least some of the included trials had selection, performance, detection, attrition and reporting bias. These types of bias would tend to exaggerate treatment effectiveness. Given this review did not demonstrate treatment effectiveness these forms of bias are probably not important.
[4] Post data of the control group in Horsley 2007 (the corresponding data in Analysis 4.1 is not post data).

[5] Calculations based on the control group baseline mean (SD) pain: 0.4 (1.1) points on a 0-10 scale (from Horsley 2007).
[6] The quality of the evidence was downgraded due to indirectness and imprecision. The downgrading for indirectness was because the results are only based on studies involving people with stroke and spinal cord injury thereby limiting their generalisability. The downgrading for imprecision was because the 95% CI is wide, particularly when the results are expressed as a relative % change (the 95% CI is narrow when the results are expressed as an absolute risk difference).
[7] Post data of the control group in Horsley 2007 (the corresponding data in Analysis 6.1 is not post data).
[8] Calculations based on the control group baseline mean (standard deviation) activity limitation: 0.3 (0.6) points on an 18-point Upper Limb Activity scale (from Horsley 2007).
[9] The quality of the evidence was downgraded due to indirectness and imprecision. The downgrading for indirectness was because the results are only based on studies involving people with stroke, cerebral palsy and Charcot-Marie-Tooth disease thereby limiting their generalisability. The downgrading for imprecision was because the 95% CI was wide particularly when the results are expressed as a relative % change (the 95% CI is narrow when the results are expressed as an absolute risk difference).

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BACKGROUND

Description of the condition

Contractures are common in people with neurological conditions including stroke, spinal cord injury, acquired brain injury and cerebral palsy (Diong 2012; Fergusson 2007; Kwah 2012). They are also common in people with non-neurological conditions associated with various musculoskeletal conditions and diseases including rheumatoid arthritis, surgery and burns (Fergusson 2007). Contractures are characterised by a reduction in joint range of motion or an increase in resistance to passive joint movement (Fergusson 2007; Fox 2000), both limiting joint mobility.

The causes of contractures are not well known. However, it is generally agreed that contractures are due to both neurally and non-neurally mediated factors (Lieber 2004). Neurally mediated factors refer to spasticity which directly limits the extensibility of the muscle-tendon unit. Spasticity is only present in people with neurological conditions and hence is only relevant in these individuals. In contrast, non-neurally mediated factors can play a role in the development of contractures in people with all types of conditions. The term is used to refer to structural changes in the muscle-tendon unit and other soft tissue structures overlying joints which together limit joint mobility. Debate exists over the relative contribution of different soft tissue structures to non-neurally mediated contractures. Some animal studies indicate the importance of muscle fibre length (Tabary 1972; Williams 1978) while other studies suggest that muscle tendons may also play a role (Herbert 1997). Whilst the exact causes of contractures remain an area of debate, the deleterious consequences of contractures are clear. They interfere with activities of daily living and can cause pain, sleep disturbances and pressure ulcers (Harvey 2002; Clavet 2015; Scott 1981). They can also result in unsightly deformities and increase burden of care (Fergusson 2007; Harvey 2002). For these reasons considerable time and therapeutic resources are directed at treating and preventing contractures.

Description of the intervention

Stretch is widely used for the treatment and prevention of contractures. The aim of stretch is to maintain or increase joint mobility by influencing the extensibility of soft tissues spanning joints. Stretch can be administered with splints and positioning programmes, or with casts which are changed at regular intervals (serial casts). Alternatively, stretch can be self-administered or applied manually by therapists (for over 100 examples of techniques used to administer stretches see www.physiotherapyexercises.com). All techniques involve the mechanical elongation of soft tissues for varying periods of time. Some techniques can only be applied for short periods of time. For example, it is difficult for therapists to apply stretches through their hands for more than a few minutes. Other techniques, such as positioning, provide a way of administering stretch for sustained periods of time. Splints or serial casts are used to provide stretch for even longer periods and are sometimes used to provide uninterrupted stretch for many days or even weeks.

How the intervention might work

To understand how stretch might work it is important to highlight the difference between the transient and lasting effects of stretch. The transient effects of stretch have been extensively examined in animals and humans, with and without contractures. Animal studies have shown immediate increases in the length of soft tissues with stretch (Taylor 1990). Human studies have demonstrated similar findings, with immediate increases in joint range of motion and decreases in resistance to passive joint movement (Bohannon 1984; Duong 2001; Magnusson 1995; Magnusson 1996a; Magnusson 1996b). This phenomenon is termed viscous deformation (Magnusson 1995; Weppler 2010). Importantly, the effects of viscous deformation only last briefly once the stretch is removed (Duong 2001; Magnusson 1996b).

The lasting effects of stretch are more important than any transient effects for the treatment and prevention of contractures. Unfortunately, the mechanisms underlying any possible lasting effects of stretch are less understood. Current knowledge is based on animal studies which indicate that soft tissues undergo structural adaptations in response to regular and intensive stretch (Goldspink 1974; Tabary 1972). These studies have primarily examined the effect of stretch on sarcomeres, the basic units of muscle. For example, studies on animal muscles have shown that four weeks of sustained stretch increases the number of muscle sarcomeres that are in series (Tabary 1972), with sarcomere numbers returning to normal four weeks after the last stretch (Goldspink 1974). Further animal studies have also suggested that only 30 minutes of stretch per day is required to prevent loss of sarcomeres in series (Williams 1990). Thus it would appear that animal muscles are highly adaptable in response to stretch.

On one level the results of animal studies appear to be consistent with observations in humans, suggesting that stretch induces lasting changes in joint range of motion and soft tissue extensibility. For example, the extreme extensibility of yoga enthusiasts and ballerinas is often attributed to the intensive stretch routines performed by these individuals. Furthermore, a large number of human studies (many non-randomised) also indicate that stretch increases joint range of motion and soft tissue extensibility (Decoster 2005; Leong 2002). However, these observations and results are not based on high-quality evidence and in some cases any apparent effects may be solely due to poor terminology (Weppler 2010). Consequently, there is uncertainty and controversy about the effectiveness of stretch for the treatment and prevention of contractures in clinical populations.

While contractures are associated with a variety of different conditions, there is no reason to believe that the effectiveness of stretch

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is determined by the underlying condition. However, the effectiveness of stretch may be influenced by involvement of the nervous system. For this reason, we have divided this review into two, namely the effectiveness of stretch for neurological and non-neurological conditions.

Why it is important to do this review

A large amount of healthcare resources are allocated to the administration of stretch for the treatment and prevention of contractures. A systematic review is required to determine what is known of the effects of this intervention. It is hoped that the results of this systematic review will guide clinical practice and future research.

OBJECTIVES

The aim of this review was to determine the effects of stretch on contractures in people with, or at risk of developing, contractures.The outcomes of interest were joint mobility, quality of life, pain, activity limitations, participation restrictions, spasticity and adverse events.

METHODS

Criteria for considering studies for this review

Types of studies

We included published and unpublished randomised controlled trials (RCTs) and controlled clinical trials (CCTs). We included studies regardless of language. Studies that used parallel-group designs, within-subject designs or cross-over designs were all included.

Types of participants

Participants could be of any age or either gender provided they had existing contractures or were at risk of developing contractures. Participants were deemed to be at risk of developing contractures based on the clinical judgement of the Review authors, or if they had one or more of the following conditions:

- neurological conditions (e.g. stroke, multiple sclerosis, spinal cord injury, acquired brain injury, Guillain Barré syndrome, Parkinson's disease);
- advanced age (e.g. frailty);
- a history of trauma or surgery (e.g. burns, joint replacement surgery);
- underlying joint or muscle pathology and disease processes (e.g. inflammatory arthritis, osteoarthritis).

We separated participants according to their diagnoses, and then categorised them as having either a neurological or non-neurological condition.

Types of interventions

Interventions

We included any stretch intervention that aimed to maintain or increase the mobility of any synovial joint. To be included, the stretch needed to sustain the soft tissues in a lengthened position for a minimum of 20 seconds on more than one occasion. This was considered to be the minimum plausible period of stretch that was likely to affect joint mobility. Examples of stretch interventions that were eligible, based on these criteria, were sustained passive stretching, positioning, splinting and serial casting.
We excluded interventions that were described as moving joints throughout range (that is, where the soft tissues were not sustained in a lengthened position). Examples of interventions that were excluded, based on this criterion, were joint mobilisation, joint manipulation, continuous passive motion, passive movements and active movements.

Comparisons

We included all studies that allowed the effects of stretch to be isolated. We included studies if they compared:

- stretch versus no stretch;
- stretch versus placebo or sham stretch;
- stretch plus co-intervention versus co-intervention. We accepted all co-interventions provided they were applied in the same manner to both the treatment and control groups.

To reduce the complexity of the review we excluded studies that compared the effectiveness of competing interventions. Therefore, we excluded studies if they compared:

- stretch versus another stretch;
- stretch versus another active intervention.

Types of outcome measures

Outcomes included measures of impairment, activity limitations and participation restrictions. To be included in this review studies needed to have measured joint mobility, the primary focus of this review. This focus is justified because joint mobility is the key outcome used to deem the success of stretch interventions. Without a change in joint mobility there is no known mechanism for changes in activity limitations or participation restrictions.

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Major outcomes

The major outcomes of interest were joint mobility, quality of life, pain (for example, visual analogue scale, Huskisson 1974), activity limitations (for example, Functional Independence Measure, Keith 1987; or Motor Assessment Scale, Carr 1985), participation restrictions (for example, return to work), and adverse events.
All measures of joint mobility were accepted. Some of the more commonly used measures of joint mobility were:

- active joint range of motion (expressed in degrees);
- passive joint range of motion (expressed in degrees); and
- passive joint stiffness (expressed in degrees per unit of torque).

Both uni-directional measures of joint range of motion (for example, maximal ankle dorsiflexion) and bi-directional measures of joint range of motion (for example, arc of movement between maximal ankle dorsiflexion and maximal ankle plantarflexion) were eligible for inclusion. Data were expressed in millimetres in studies that used linear measures to reflect range of motion (for example, tests of combined hip and knee range of motion reflected by finger-tip to floor distance).
Quality of life provides a holistic measure of the effectiveness of stretch. There may be people with contractures whose quality of life does not improve even with improvements in joint mobility. Therefore, we also selected quality of life as a major outcome. Examples of commonly used quality-of-life measures include:

- Short Form 36 (Ware 1992); and
- Assessment of Quality of Life (Hawthorne 1999; Hawthorne 2001).

Minor outcome

A minor outcome of interest was spasticity which was only relevant for people with neurological conditions (for example, Tardieu scale, Tardieu 1954; or modified Ashworth scale, Bohannon 1987).

Timing of outcome assessment

Outcomes could be measured at any time following intervention. We grouped outcomes into two main categories which were classified according to the time after which the stretch intervention was ceased:

- short-term effects following stretch (outcomes measured up to one week after the last stretch ceased);
- long-term effects following stretch (outcomes measured more than one week after the last stretch ceased).

If studies collected data at multiple points within one of the predetermined time periods then we used data collected at the latest time.

Adverse outcomes

We classified adverse outcomes into the following groups: muscle tears, joint subluxation or dislocation, heterotopic ossification, pain or other adverse outcome. We contacted study authors for incomplete reporting of adverse events and losses to follow-up where possible. We asked them to explain why participants withdrew.

Search methods for identification of studies

Electronic searches

We conducted electronic searches to identify potential studies. There was no language restriction applied to any component of the search strategies. We searched the following electronic databases (see appendices for details):

- Cochrane Central Register of Controlled Trials (CENTRAL), The Database of Abstracts of Reviews of Effects (DARE) and The Health Technology Assessment Database (HTA) (The Cochrane Library 2015, Issue 11), (Appendix 1);
- MEDLINE (Ovid) (1950 to 19 November 2015), (Appendix 2);
- Embase (Ovid) (1980 to 19 November 2015), (Appendix 3);
- CINAHL (Ovid) (1982 to 19 November 2015), (Appendix 4);
- SCI-EXPANDED (ISI Web of Knowledge) (1900 to 19 November 2015), (Appendix 5);
- PEDro (www.pedro.org.au), (inception to 19 November 2015), (Appendix 6).

Searching other resources

The electronic searches were complemented with a search of the reference lists of included studies and relevant systematic reviews. We also used forward citation tracking of included studies to search for additional studies using the ISI Web of Knowledge. We contacted authors of included studies for additional studies and unpublished data.
We also searched the World Health Organization International Clinical Trials Registry Platform (www.who.int/trialsearch) and clinicaltrials.gov/ to identify unpublished and ongoing trials.

Data collection and analysis

Selection of studies

Two review authors independently screened the titles and abstracts of the search output to identify potentially relevant studies. We retrieved full-length reports of all potentially relevant studies and re-examined them to ensure that they met the inclusion criteria.

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The two review authors resolved any disagreements by discussion and, when necessary, a third author arbitrated.

Data extraction and management

Two review authors independently extracted data from the included studies using pre-constructed data extraction forms. They extracted the following data:

- study design, inclusion criteria and exclusion criteria;
- characteristics of the participants including the type of health condition, number of participants, age, gender, and whether participants were at risk of developing contracture or had existing contracture, or a combination of the two;
- characteristics of the intervention and comparison including details of treatment and control interventions, duration of intervention, frequency of intervention, intensity of intervention, details of co-interventions, compliance with treatment and treated joint;
- details of the primary and secondary outcomes:
    - methods used to measure joint mobility,
    - time between last stretch and outcome measurement,
    - mean scores and standard deviations of outcomes for each treatment group,
    - direction of effect for each outcome; and
- adverse events.

We standardised the direction of effect for each outcome between studies, with the direction of effect selected for each outcome as follows.

- Joint mobility: positive between-group difference favoured stretch.
- Quality of life: positive between-group difference favoured stretch.
- Pain: negative between-group difference favoured stretch.
- Spasticity: negative between-group difference favoured stretch.
- Activity limitations: positive between-group difference favoured stretch.
- Participation restrictions: positive between-group difference favoured stretch.

If outcomes were only reported graphically, we estimated means and standard deviations from the graphs. We extracted ANCOVA-adjusted between-group means and standard deviations in preference to change scores. However, if neither were provided, we used post-intervention scores.

If studies reported data as medians and inter-quartile ranges, we extracted medians and estimated standard deviations as 80% of the interquartile range.

We extracted torque-controlled measures of joint mobility in preference to all other joint mobility measures. If the studies did not report torque-controlled measures, next in order of preference were passive joint mobility measures. If passive joint mobility measures were not reported, we extracted active joint mobility measures.

Differences in the data extracted by the two review authors were resolved by discussion and, when necessary, arbitrated by a third author. Review authors did not extract data on studies in which they had been involved; data from these studies were extracted by other authors.

Assessment of risk of bias in included studies

Two review authors independently assessed the risk of bias of the included studies. As recommended in Chapter 8 of the Cochrane Handbook for Systematic Reviews of Interventions ((Higgins 2011), we assessed the following methodological domains:

- sequence generation;
- allocation sequence concealment;
- blinding of participants and therapists;
- blinding of outcome assessors for objective outcomes;
- blinding of outcome assessors for self-report outcomes;
- incomplete outcome data;
- selective outcome reporting; and
- other potential threats to validity.

We judged these domains explicitly using the following criteria: 'Yes' = low risk of bias; 'No' = high risk of bias; 'Unclear' = either lack of information or uncertainty over the potential for bias. When studies reported incomplete data in more than 15% of participants, we deemed them to have high risk of bias from incomplete outcome data.

We resolved disagreements in quality ratings by discussion or, when necessary, a third author arbitrated. Review authors did not evaluate the risk of bias of studies in which they were involved; these studies were evaluated by other authors.

Measures of treatment effect

No dichotomous outcomes were reported. For continuous outcomes we reported the mean differences for each study to provide a summary estimate of the effectiveness of stretch. For continuous outcomes with the same units, we expressed effects as mean differences (MD) and 95% confidence intervals (CI). For continuous outcomes with different units, we expressed effects as standardised mean differences (SMD) and 95% CI. SMD was back-translated to a typical scale (e.g. 0 to 10 for pain) by multiplying the SMD by a typical among-person standard deviation (e.g. the standard deviation of the control group at baseline from the most representative trial) (as per Chapter 12 of the Cochrane Handbook for Systematic Reviews of Interventions (Schünemann 2011).

In the 'Effects of intervention' results section and the 'Comments' column of the 'Summary of findings' table, we have reported the absolute percent difference, the relative percent change from baseline, and the number needed to treat for an additional beneficial outcome (NNTB) (we provided the NNTB only for the short-term effect of joint mobility in people with neurological conditions because this was the sole outcome with a statistically significant

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difference). We calculated the NNTB for joint mobility using the Wells calculator (available at the Cochrane Musculoskeletal editorial office) using a minimally clinically important difference of 5°. We calculated the absolute benefit as the improvement in the intervention group minus the improvement in the control group, in the original units, expressed as a percentage. We calculated the relative difference in the change from baseline as the absolute benefit divided by the baseline mean of the control group, expressed as a percentage.

Unit of analysis issues

Cross-over studies

We analysed cross-over studies using combined data from all study periods (Fox 2000, McNee 2007; Moseley 1997; Refshauge 2006). We back-calculated the between-group standard deviations from the presented data using the method described by Fleiss 1993. Using combined data yields more accurate weighting for cross-over studies in meta-analyses than using first period data only (Curtin 2002).

Studies with multiple treatment groups

In studies with more than two treatment groups, we only extracted data from the two groups with the most different interventions.

Studies with multiple measures for the same joint

In studies with multiple measures for the same joint, we only extracted data for the measure deemed most likely to reflect a beneficial effect of stretch. For example, we used the data reflecting shoulder rotation in studies that applied an aggressive stretch for shoulder rotation but only a mild stretch for shoulder flexion.

Studies with measures on different joints

In studies where the effects of stretch were measured across different joints, we only extracted data for the measure deemed most likely to reflect a beneficial effect of stretch. For example, in studies where the stretch involved shoulder, elbow and wrist positioning, we only extracted one set of data for the joint that was deemed most likely to respond to the stretch. Also, in instances where data were reported for both right and left sides, we always extracted the right side data in preference to the left side.

Dealing with missing data

We contacted authors of included studies when there was incomplete reporting of data. When authors of included studies were unable to provide additional data we included all available data in the review. Where possible, all analyses were performed on an intention-to-treat basis.

Assessment of heterogeneity

When there were at least two clinically homogeneous studies (studies that investigated the effect of similar interventions on similar populations and reported similar outcomes) we considered meta-analysis. In such circumstances we used the I^2 statistic to quantify the heterogeneity of outcomes and to inform decisions about whether to pool data (Higgins 2003). Where heterogeneity was substantial (I^2 > 50%), we explored the possible causes of heterogeneity in sensitivity analyses, in which individual studies were omitted one at a time or stratified by particular characteristics or, where appropriate, with meta-regression (Deeks 2011).

Assessment of reporting biases

We used funnel plots to examine the possibility of small sample bias in the estimates of the short-term effects of stretch on joint mobility for people with neurological and non-neurological conditions.

Data synthesis

We used a random-effects model to conduct meta-analyses and analysed data using Review Manager 5.3 (RevMan) (RevMan 2014). We explored the effect of stretch on the subgroups outlined below using random-effects meta-regression (see 'Subgroup analyses'). We used the user-written 'metareg routine' in the Stata Statistical Software package for this purpose.

GRADE and 'Summary of findings' tables

We compiled two 'Summary of findings' tables using GRADEpro software (GRADEpro GDT 2015); one for neurological and the other for non-neurological conditions. Both summarised the short-term effects of stretch on the following outcomes: joint mobility, quality of life, pain, activity limitations, participant restrictions and adverse events.

We reported the NNTB or the NNTH, absolute and relative per cent change in the Comments column of the 'Summary of Findings' table as described in the Measures of treatment effect section above. We also reported if the pooled result ruled out a clinically important treatment effect based on the 95% CI. The clinically important treatment effect for joint mobility and pain was 5° and 2 points (on a 10-point visual analogue scale), respectively. We did not articulate clinically important treatment effects for other outcomes but instead used clinical reasoning after considering the absolute and relative changes.

We used the GRADE approach to evaluate the quality of the evidence (GRADE Working Group 2004; Guyatt 2008a; Guyatt 2008b; Schünemann 2011). The GRADE approach specifies four levels of quality:

- high-quality, randomised trials or double-upgraded observational studies;

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- medium-quality, downgraded randomised trials or upgraded observational studies;
- low-quality, double-downgraded randomised trials or observational studies; and
- very low-quality, triple-downgraded randomised trials, downgraded observational studies or case series or case reports.

The quality of evidence was downgraded if:

- there were limitations in the design and implementation of available studies, suggesting high likelihood of bias;
- there was indirectness of evidence (indirect population, intervention, control, outcomes);
- there was unexplained heterogeneity or inconsistency of results (including problems with subgroup analyses);
- there was imprecision of results (wide confidence intervals); and
- there was a high probability of publication bias.

Subgroup analysis and investigation of heterogeneity

We conducted planned subgroup analyses to determine the following effects on joint mobility for people with neurological and non-neurological conditions:

- compare the short-term effects following stretch (i.e. effects present less than one week after the last stretch was ceased) with the long-term effects following stretch (i.e. effect present more than one week after the last stretch was ceased);
- compare the effects of stretch administered to different populations (i.e. the effects of stretch administered to people with stroke versus spinal cord injury versus acquired brain injury versus cerebral palsy, etc.);
- determine the effects of different stretch dosages (i.e. total stretch time);
- determine the effects of different stretch interventions (i.e. the effects of stretch administered manually by therapists versus the effects of self-administered stretch versus the effects of stretch administered with positioning programmes versus the effects of stretch administered with plaster casts versus the effects of stretch administered with splints);
- determine the effects of stretch when administered to large joints (e.g. shoulder, elbow, hip and knee) versus small joints (e.g. wrist, ankle, hand and foot);
- determine the effects of stretch when outcomes could be influenced by participants' perceptions of discomfort (e.g. measures of active range of motion, measures of passive range of motion with a non-standardised measurement torque) versus when outcomes could not be influenced by participants' perceptions of discomfort (e.g. studies involving unconscious or insensate people, measurements taken with a standardised torque) (Harvey 2002; Weppler 2010);
- determine the effects of stretch administered for the treatment of contractures versus the effects of stretch administered for the prevention of contractures; and
- determine the effects of stretch when measurements were taken less than one day after the last stretch versus when measurements were taken more than one day after the last stretch.

We used the formal test for subgroup interactions in RevMan 2014 to aid in the interpretation of subgroup analyses. We compared the magnitude of the effects between the subgroups by assessing the overlap of the CIs of the summary estimates. CIs that did not overlap indicated statistical significance.

Sensitivity analysis

To examine the robustness of the findings to potential selection, detection and attrition biases, we conducted sensitivity analyses. The sensitivity analyses examined the effects on joint mobility of randomisation (adequate versus inadequate sequence generation), allocation concealment (concealed versus non-concealed allocation), blinding of assessors (blinding versus no blinding) and completeness of outcome data (complete versus incomplete outcome data available).

RESULTS

Description of studies

Results of the search

The electronic searches, citation tracking and reference list searches produced 5048 references. After screening titles and abstracts, we identified 135 studies as potentially eligible. After inspecting the full reports, we included 49 studies, with four studies awaiting classification and one study ongoing (see Figure 1). We excluded 86 studies and have summarised the reasons for exclusion in the Characteristics of excluded studies table.

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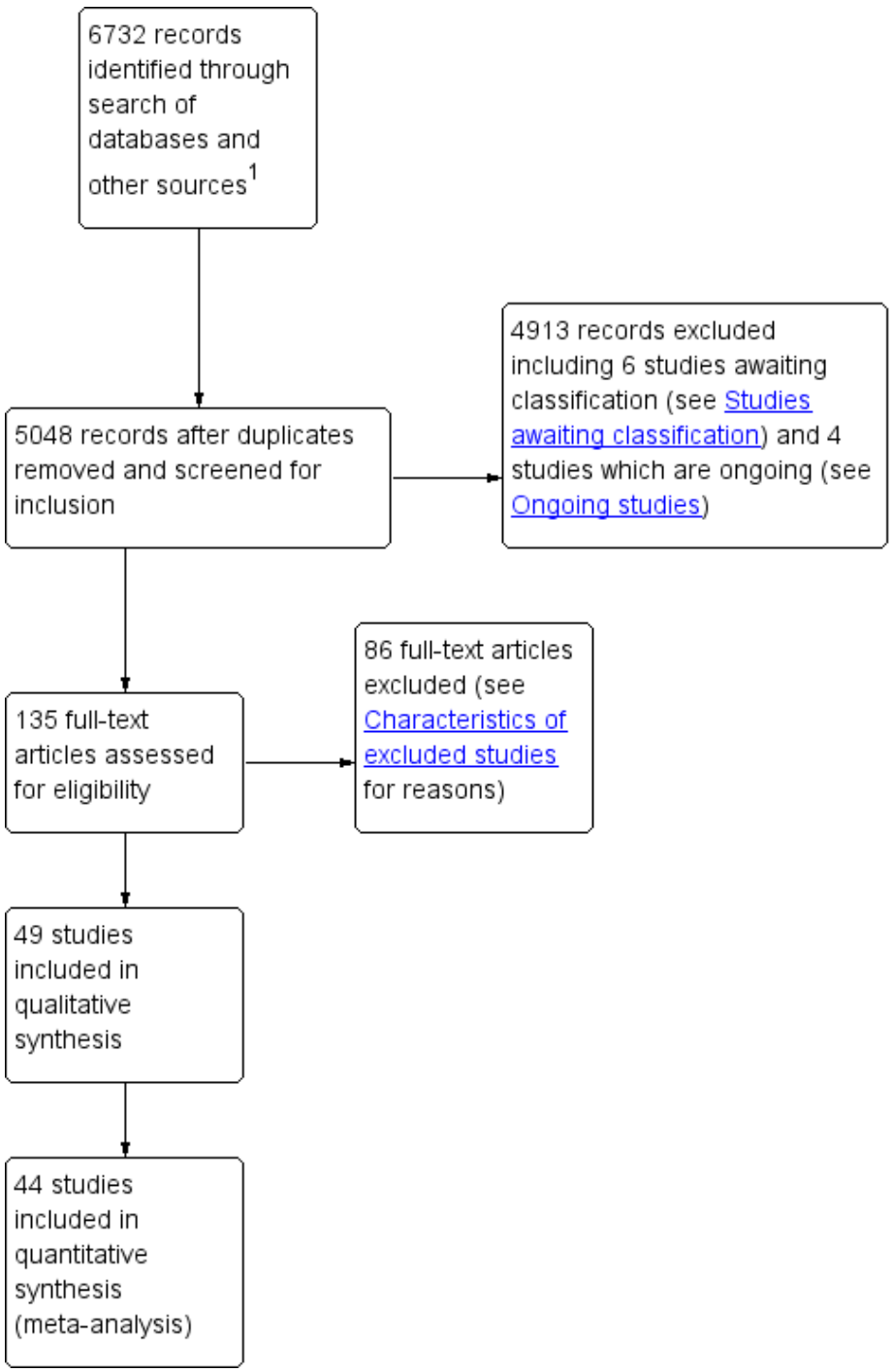
Figure 1. Study flow diagram1. These numbers are approximate only



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Included studies

We included 49 studies with a total of 2135 participants.

Twenty-eight studies with a total of 898 participants investigated the effects of stretch in people with neurological conditions (Ackman 2005; Ada 2005; Basaran 2012; Ben 2005; Burge 2008; Copley 2013; Crowe 2000; De Jong 2006; Dean 2000; DiPasquale-Lehnerz 1994; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Hill 1994; Horsley 2007; Hyde 2000; Krumlinde-Sundholm 2011; Lai 2009; Lannin 2003a; Lannin 2007a; Law 1991; McNee 2007; Moseley 1997; Refshauge 2006; Rose 2010; Sheehan 2006; Turton 2005) and included people with stroke, spinal cord injury, acquired brain injury, cerebral palsy, Charcot-Marie-Tooth disease and Duchenne muscular dystrophy. One study recruited people with spinal cord injury, acquired brain injury and stroke (Harvey 2006). In this study, participants were separated according to their diagnoses.

Twenty-one studies with a total of 1237 participants investigated the effects of stretch in people with non-neurological conditions (Aoki 2009; Buchbinder 1993; Bulstrode 1987; Collis 2013; Cox 2009; Fox 2000; Horton 2002; Hussein 2015; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lee 2007; Melegati 2003; Moseley 2005; Paul 2014; Seeger 1987; Steffen 1995; Zenios 2002) and included people with osteoarthritis, Dupuytren's contractures, frozen shoulder, knee replacement surgery, wrist fracture, ankle fracture, hallux limitus, anterior cruciate reconstruction surgery, ankle fracture, ankylosing spondylitis, radiotherapy for breast cancer, burns, radiotherapy to the jaw, systemic sclerosis and frailty.

The following types of stretch were administered in all studies: passive stretching (self-administered, therapist-administered and device-administered), positioning, splinting and serial casting. The stretch dosage was highly variable, ranging from five minutes to 24 hours per day (median 420 minutes, IQR 38 to 600) for between two days and seven months (median 35 days, IQR 23 to 84). The total cumulative time that stretch was administered ranged from 23 minutes to 1456 hours (median 168 hours, IQR 24 to 672).

All included studies reported joint mobility, while only three studies reported quality of life (Buchbinder 1993; Kolmus 2012; Lee 2007). Eighteen studies reported pain (Ada 2005; Aoki 2009; Buchbinder 1993; Burge 2008; Cox 2009; Crowe 2000; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Horsley 2007; Hussein 2015; Kemler 2012; Lannin 2003a; Lannin 2007a; Lee 2007; Moseley 2005; Paul 2014) and eight studies reported spasticity (Ackman 2005; Basaran 2012; Burge 2008; Copley 2013; De Jong 2006; Hill 1994; Lai 2009; Lannin 2007a). Activity limitations were reported in 21 studies (Ada 2005; Aoki 2009; Collis 2013; Crowe 2000; De Jong 2006; DiPasquale-Lehnerz 1994; Gustafsson 2006; Hill 1994; Horsley 2007; Hussein 2015; Hyde 2000; Jerosch-Herold 2011; Jongs 2012; Kolmus 2012; Lannin 2003a; Lannin 2007a; Law 1991; McNee 2007; Moseley 2005; Paul 2014; Rose 2010) and three studies reported participation restrictions (Harvey 2006; Jongs 2012; Moseley 2005).

Forty-five studies investigated the short-term effects following stretch (that is, outcomes were measured less than one week after the last stretch was ceased) (Ada 2005; Aoki 2009; Basaran 2012; Ben 2005;, Buchbinder 1993; Bulstrode 1987; Burge 2008; Collis 2013; Copley 2013; Cox 2009; Crowe 2000; De Jong 2006; Dean 2000; DiPasquale-Lehnerz 1994; Fox 2000; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Hill 1994; Horsley 2007; Horton 2002; Hussein 2015; Hyde 2000; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Krumlinde-Sundholm 2011; Lai 2009; Lannin 2003a; Lannin 2007a; Law 1991; Lee 2007; Moseley 1997; Moseley 2005; Paul 2014; Refshauge 2006; Rose 2010; Seeger 1987; Sheehan 2006; Steffen 1995; Turton 2005). Eighteen studies investigated the long-term effects following stretch (that is, outcomes were measured more than one week after the last stretch was ceased) (Ackman 2005; Bulstrode 1987; Copley 2013; Gustafsson 2006; Harvey 2000; Horsley 2007; Horton 2002; Hussein 2015; Jerosch-Herold 2011; Jongs 2012; Kemler 2012; Lannin 2003a; Lannin 2007a; Law 1991; McNee 2007; Melegati 2003; Moseley 2005; Zenios 2002).

Five studies (DiPasquale-Lehnerz 1994; Hill 1994; Hyde 2000; Krumlinde-Sundholm 2011; Sheehan 2006) did not provide any useable data for any of the analyses and are described qualitatively in Characteristics of included studies. Characteristics of all other included studies are also detailed in the 'Characteristics of included studies' tables.

Excluded studies

We excluded 86 studies (for reasons see Characteristics of excluded studies).

Risk of bias in included studies

The risk of bias in the 49 included studies was variable. We have summarised results in Figure 2, with further details about the risk of bias in the included studies reported in the Characteristics of included studies tables.

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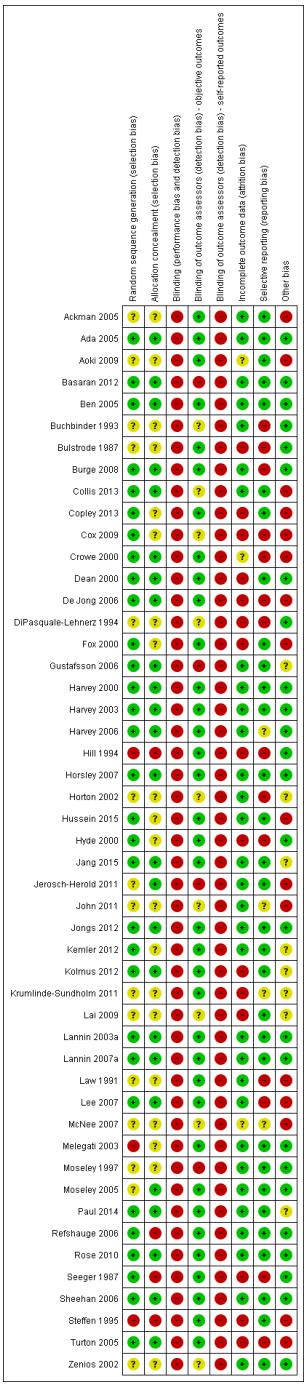
Figure 2. Methodological quality summary: review authors' judgements about each methodological quality item for each included study



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Allocation

Thiry-one studies (63%) used adequate methods for generating the randomisation sequence whilst 25 studies (51%) used adequate methods to conceal allocation (see Figure 2 and 'Characteristics of included studies' tables).

Blinding

Blinding of participants and therapists was not possible in any of the studies due to the nature of the intervention. Thirty-six studies (73%) blinded assessors of objective outcomes to group allocation (see Figure 2 and 'Characteristics of included studies' tables).

Incomplete outcome data

Thirty-one studies (63%) were free of selective outcome reporting (see Figure 2 and 'Characteristics of included studies' tables).

Selective reporting

Thirty-one studies (63%) had complete outcome data (see Figure 2 and 'Characteristics of included studies' tables).

Other potential sources of bias

Twenty-six studies (53%) were free of other bias (see Figure 2 and 'Characteristics of included studies' tables).

Effects of interventions

See: **Summary of findings for the main comparison** Short-term effects of stretch for the treatment and prevention of contractures in people with neurological conditions; **Summary of findings 2** Short-term effects of stretch for the treatment and prevention of contractures in people with non-neurological conditions

The included studies all compared stretch plus co-intervention versus co-intervention. Co-interventions included usual care, botulinum toxin, passive stretches, exercise and therapy. The studies applied the co-interventions in the same manner to both groups.

All but four studies measured joint mobility in degrees (Buchbinder 1993; Cox 2009; Melegati 2003; Sheehan 2006). All four studies involved people with non-neurological conditions and hence we expressed the short- and long-term effects of stretch for non-neurological conditions as standardised mean difference (SMD). Quality of life, spasticity, activity limitations and participation restrictions were measured using various scales and therefore we expressed results as SMDs and back-translated them to a common scale. The exception was pain. In some analyses, pain was uniformly measured using the 100 mm visual analogue scale. We therefore expressed results for these analyses as mean differences (MD). When only one study was included in an analysis, we reported the results as MDs using the scales of the study.

Where sufficient data were available we included all studies in analyses; that is, where means and standard deviations could be extracted or estimated. All analyses were initially restricted to each sub-group of participants, however, there were no statistically significant differences between sub-groups within the neurological or non-neurological conditions for any outcome. Therefore we pooled the results across the sub-groups within neurological and non-neurological condition (see Analysis 1.1 to Analysis 9.1).

We evaluated the quality of evidence using the GRADE approach for the short-term effect of stretch on joint mobility, quality of life, pain, activity limitations, participation restrictions and adverse events for neurological conditions (see Summary of findings for the main comparison) and non-neurological conditions (see Summary of findings 2). The results of all analyses are reported below.

Joint mobility

Short-term effects following stretch

Neurological conditions

Twenty-six studies with a total of 699 participants investigated the short-term effects on joint mobility following stretch in people with neurological conditions (Ada 2005; Basaran 2012; Ben 2005; Burge 2008; Copley 2013; Crowe 2000; De Jong 2006; Dean 2000; DiPasquale-Lehnerz 1994; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Hill 1994; Horsley 2007; Hyde 2000; Krumlinde-Sundholm 2011; Lai 2009; Lannin 2003a; Lannin 2007a; Law 1991; Moseley 1997; Refshauge 2006; Rose 2010; Sheehan 2006; Turton 2005). Eighteen studies with a total of 549 participants provided sufficient data (Ada 2005; Basaran 2012; Ben 2005; Copley 2013; De Jong 2006; Dean 2000; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Horsley 2007; Lai 2009; Lannin 2003a; Lannin 2007a; Moseley 1997; Refshauge 2006; Rose 2010; Turton 2005). The participants included people with stroke, Charcot-Marie-Tooth disease, acquired brain injury and spinal cord injury. The mean difference (MD) was 2° (95% CI 0° to 3°; I^2 = 37%; P = 0.009) (see Analysis 1.1; Figure 3; Summary of findings for the main comparison). The GRADE quality of evidence for this result was high.

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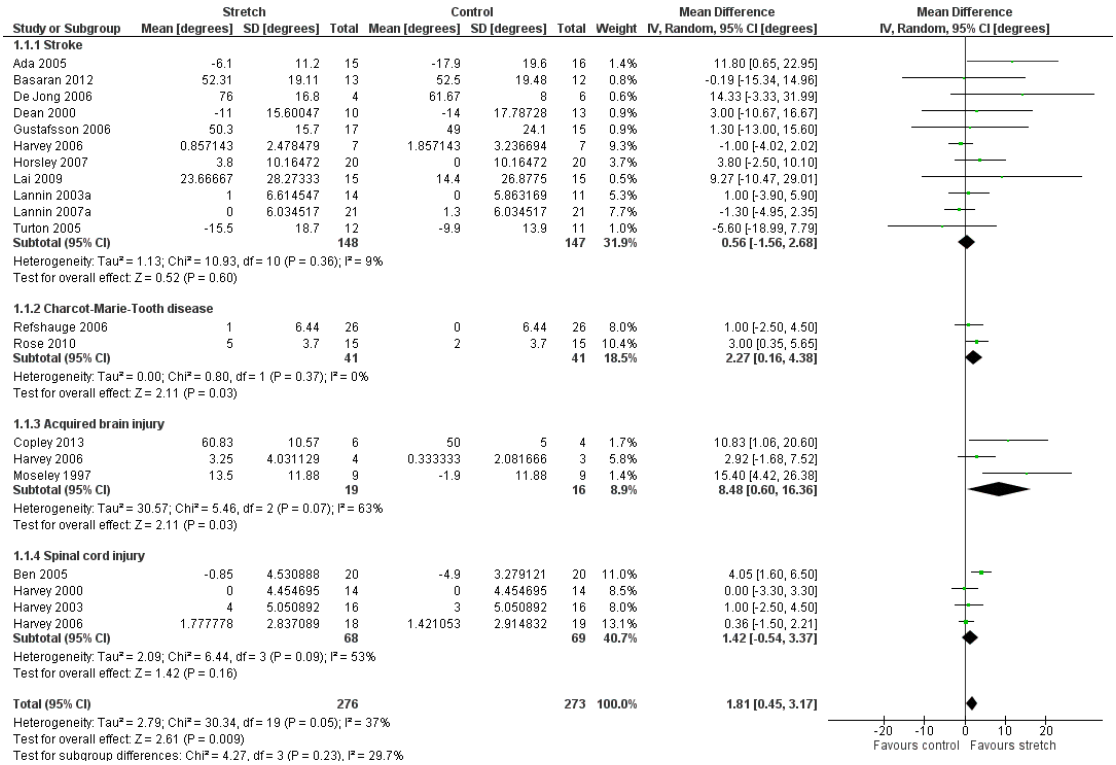
Figure 3. Forest plot of comparison: Joint mobility - short-term effects following stretch - neurological conditions (degrees)



Non-neurological conditions

Nineteen studies with a total of 925 participants investigated the short-term effects on joint mobility following stretch in people with non-neurological conditions (Aoki 2009; Buchbinder 1993; Bulstrode 1987; Collis 2013; Cox 2009; Fox 2000; Horton 2002; Hussein 2015; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lee 2007; Moseley 2005; Paul 2014; Seeger 1987; Steffen 1995). All studies provided sufficient data but two studies (Buchbinder 1993; Cox 2009) did not measure joint mobility in degrees and hence data were pooled using a SMD. There was substantial statistical heterogeneity between studies (I^2 = 67%) and the SMD was 0.3 (95% CI 0.1 to 0.6). The main reason for this heterogeneity was the Hussein 2015 study. The results for two of its three outcomes included in this review were between 5 and 30 times greater than the results for any other study. There was no obvious explanation for this but the extreme results all favouring the experimental condition seemed implausible. Therefore 18 studies with a total of 865 participants were included in the analyses (Aoki 2009; Buchbinder 1993; Bulstrode 1987; Collis 2013; Cox 2009; Fox 2000; Horton 2002; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lee 2007; Moseley 2005; Paul 2014; Seeger 1987; Steffen 1995). The participants included frail elderly and people with ankle fracture, anklylosing spondylitis, oral submucous fibrosis, post-radiation therapy to the breast, post-radiation therapy to jaw, progressive systemic sclerosis, total knee replacement, arthritis, Dupuytren's contractures, shoulder adhesive capsulitis/frozen shoulder, hallux limitus, wrist fracture and burns. The SMD was 0.2 (95% CI 0.0 to 0.3; I^2 = 28%; P = 0.05) (see Analysis 1.2; Figure 4; Summary of findings 2).The GRADE quality of evidence for this result was high.

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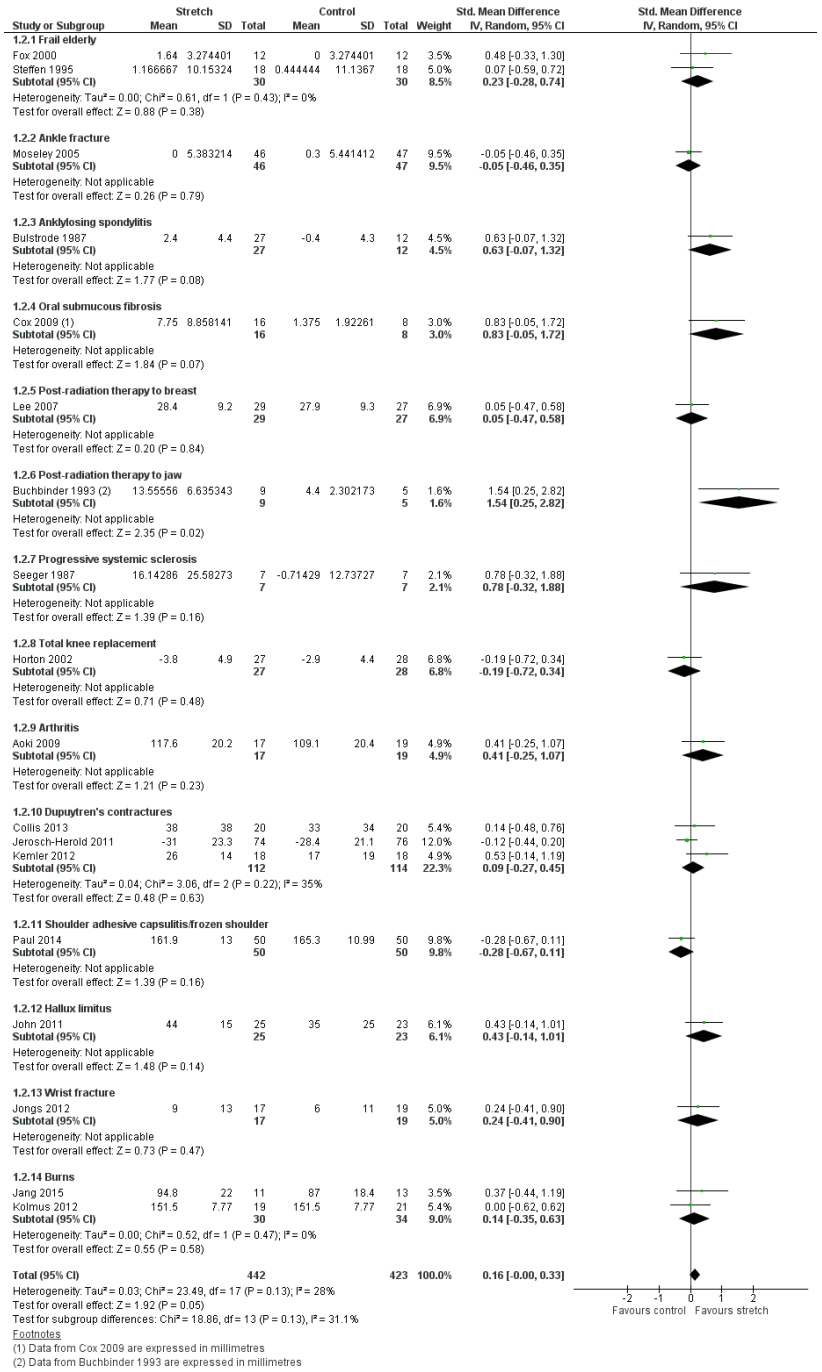
Figure 4. Forest plot of comparison: Joint mobility - short-term effects following stretch - non-neurological conditions (SMD)



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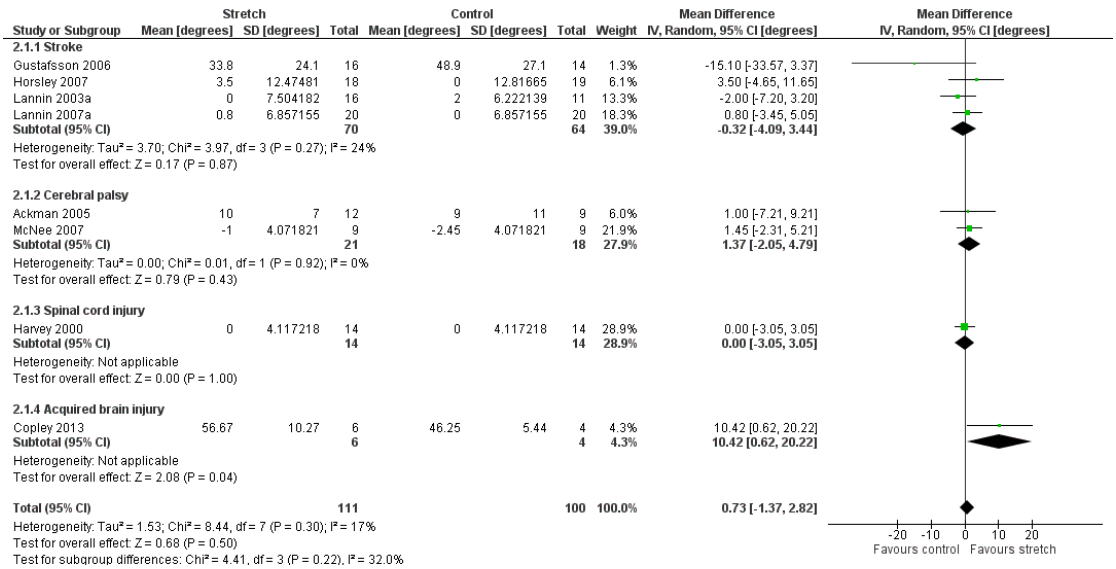
Long-term effects following stretch

Neurological conditions

Nine studies with a total of 248 participants investigated the long-term effects on joint mobility following stretch in people with neurological conditions (Ackman 2005; Copley 2013; Gustafsson 2006; Harvey 2000; Horsley 2007; Lannin 2003a; Lannin 2007a; Law 1991; McNee 2007). Eight studies with a total of 211 participants provided sufficient data (Ackman 2005; Copley 2013; Gustafsson 2006; Harvey 2000; Horsley 2007; Lannin 2003a; Lannin 2007a; McNee 2007). The participants included people with stroke, cerebral palsy, spinal cord injury and acquired brain injury. The MD was 1° (95% CI -1 to 3; I^2 = 17%; P = 0.50) (see Analysis 2.1; Figure 5).

Figure 5. Forest plot of comparison: Joint mobility - long-term effects following stretch - neurological conditions (degrees)



Non-neurological conditions

Nine studies with a total of 558 participants investigated the long-term effects on joint mobility following stretch in people with non-neurological conditions (Bulstrode 1987; Horton 2002; Hussein 2015; Jerosch-Herold 2011; Jongs 2012; Kemler 2012; Melegati 2003; Moseley 2005; Zenios 2002). Seven studies with a total of 498 participants provided sufficient data (Hussein 2015; Jerosch-Herold 2011; Jongs 2012; Kemler 2012; Melegati 2003; Moseley 2005; Zenios 2002) but one study (Melegati 2003) did not measure joint mobility in degrees and hence data were pooled using a SMD. There was substantial statistical heterogeneity between studies (I^2 = 94%) and the SMD was 0.6 (95% CI -0.2 to

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1.5). The main reason for this heterogeneity was the Hussein 2015 study. As indicated in the short-term effects following stretch section, this study had very large, implausible effects so we decided to omit it from the analysis. Therefore six studies with a total of 438 participants were included in the analyses (Jerosch-Herold 2011; Jongs 2012; Kemler 2012; Melegati 2003; Moseley 2005; Zenios 2002). The participants included people with anterior cruciate ligament reconstruction, ankle fracture, total knee replacement, Dupuytren's contracture and wrist fracture. The SMD was -0.1 (95% CI -0.4 to 0.2; I^2 = 42%; P = 0.43) (see Analysis 2.2).

Quality of life

Short-term effects following stretch

Neurological conditions

No study measured a quality of life outcome during this time period.

Non-neurological conditions

Three studies with a total of 111 participants investigated the short-term effects on quality of life following stretch in people with non-neurological conditions (Buchbinder 1993; Kolmus 2012; Lee 2007). Two studies with a total of 97 participants provided sufficient data (Lee 2007; Kolmus 2012). The participants included people post radiation therapy and with burns. The SMD was 0.3 (95% CI -0.1 to 0.7; I^2 = 0%; P = 0.13) (see Analysis 3.1; Summary of findings 2).The GRADE quality of evidence for this result was moderate.

Long-term effects following stretch

Neurological conditions

No study measured a quality of life outcome during this time period.

Non-neurological conditions

No study measured a quality of life outcome during this time period.

Pain

Short-term effects following stretch

Neurological conditions

Nine studies with a total of 265 participants investigated the short-term effects on pain following stretch in people with neurological conditions (Ada 2005; Burge 2008; Crowe 2000; De Jong 2006; Dean 2000; Gustafsson 2006; Horsley 2007; Lannin 2003a; Lannin 2007a). Five studies with a total of 174 participants provided sufficient data (Crowe 2000; Gustafsson 2006; Horsley 2007; Lannin 2003a; Lannin 2007a). The participants included people with stroke and spinal cord injury. The SMD was 0.2 (95% CI -0.1 to 0.5; I^2 = 0%; P = 0.19) (see Analysis 4.1; Summary of findings for the main comparison).The GRADE quality of evidence for this result was low.

Non-neurological conditions

Nine studies with a total of 460 participants investigated the short-term effects on pain following stretch in people with non-neurological conditions (Aoki 2009; Buchbinder 1993; Cox 2009; Fox 2000; Hussein 2015; Kemler 2012; Lee 2007; Moseley 2005; Paul 2014). Seven studies with a total of 422 participants provided sufficient data (Aoki 2009; Fox 2000; Hussein 2015; Kemler 2012; Lee 2007; Moseley 2005; Paul 2014). The participants included frail elderly people and people with ankle fracture, post-radiation therapy to the breast, arthritis, shoulder adhesive capsulitis/frozen shoulder and Dupuytren's contracture. The SMD was -0.2 (95% CI -0.4 to 0.1; I^2 = 44%; P = 0.22) (see Analysis 4.2; Summary of findings 2). The GRADE quality of evidence for this result was high.

Long-term effects following stretch

Neurological conditions

Four studies with a total of 132 participants investigated the long-term effects on pain following stretch in people with neurological conditions (Gustafsson 2006; Horsley 2007; Lannin 2003a; Lannin 2007a). All studies provided sufficient data. The participants included people with stroke. The SMD was 0 (95% CI -0.4 to 0.5; I^2 = 38%; P = 0.90) (see Analysis 5.1).

Non-neurological conditions

Three studies with a total of 204 participants investigated the long-term effects on pain following stretch in people with non-neurological conditions (Hussein 2015; Kemler 2012; Moseley 2005).

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Two studies with a total of 150 participants provided sufficient data (Hussein 2015; Moseley 2005). Data were not pooled due to clinical heterogeneity between studies. The participants included people with shoulder adhesive capsulitis and ankle fracture. The point estimates of effect of the two studies were -0.6 and 0 on a 10 cm visual analogue scale (see Analysis 5.2).

Activity limitations

Short-term effects following stretch

Neurological conditions

Twelve studies with a total of 321 participants investigated the short-term effects on activity limitations following stretch in people with neurological conditions (Ada 2005; Crowe 2000; De Jong 2006; DiPasquale-Lehnerz 1994; Gustafsson 2006; Hill 1994; Horsley 2007; Hyde 2000; Lannin 2003a; Lannin 2007a; Law 1991; Rose 2010). Eight studies with a total of 247 participants provided sufficient data (Ada 2005; De Jong 2006; Gustafsson 2006; Horsley 2007; Lannin 2003a; Lannin 2007a; Law 1991; Rose 2010). There was substantial statistical heterogeneity between studies (I^2 = 56%) and the SMD was 0.3 (95% CI -0.1 to 0.7). After exploring the reasons for this heterogeneity we decided to exclude the De Jong 2006 study because author correspondence revealed that some of the participants received confounding interventions including botulinum toxin injections, and additional physiotherapy and occupational therapy. Therefore seven studies with a total of 237 participants were included in the analyses (Ada 2005; Gustafsson 2006; Horsley 2007; Lannin 2003a; Lannin 2007a; Law 1991; Rose 2010). The participants included people with stroke, cerebral palsy and Charcot-Marie-Tooth disease. The SMD was 0.2 (95% CI -0.1 to 0.5; I^2 = 37%; P = 0.25) (see Analysis 6.1; Summary of findings for the main comparison). The GRADE quality of evidence for this result was low.

Non-neurological conditions

Eight studies with a total of 556 participants investigated the short-term effects on activity limitations following stretch in people with non-neurological conditions (Aoki 2009; Collis 2013; Hussein 2015; Jerosch-Herold 2011; Jongs 2012; Kolmus 2012; Moseley 2005; Paul 2014). Six studies with a total of 416 participants provided sufficient data (Aoki 2009; Hussein 2015; Jerosch-Herold 2011; Jongs 2012; Kolmus 2012; Moseley 2005). There was substantial statistical heterogeneity between studies (I^2 = 85%) and the SMD was 0.2 (95% CI -0.3 to 0.7). The main reason for this heterogeneity was the Hussein 2015 study. As indicated in the short-term effects following stretch section, this study had very large, implausible effects so we decided to omit it from the analysis. Therefore five studies with a total of 356 participants were included in the analyses (Aoki 2009; Jerosch-Herold 2011; Jongs 2012; Kolmus 2012; Moseley 2005). The participants included people with ankle fracture, arthritis, Dupuytren's contracture, wrist fracture and burns. The SMD was 0.1 (95% CI -0.2 to 0.3; I^2 = 25%; P = 0.49) (see Analysis 6.2; Summary of findings 2). The GRADE quality of evidence for this result was high.

Long-term effects following stretch

Neurological conditions

Six studies with a total of 191 participants investigated the long-term effects on activity limitations following stretch in people with neurological conditions (Gustafsson 2006; Horsley 2007; Lannin 2003a; Lannin 2007a; Law 1991; McNee 2007). All studies provided sufficient data. The participants included people with stroke and cerebral palsy. The SMD was 0.2 (95% CI -0.1 to 0.6; I^2 = 25%; P = 0.19) (see Analysis 7.1).

Non-neurological conditions

Four studies with a total of 328 participants investigated the long-term effects on activity limitations following stretch in people with non-neurological conditions (Hussein 2015; Jerosch-Herold 2011; Jongs 2012; Moseley 2005). There was substantial statistical heterogeneity between studies (I^2 = 91%) and the SMD was 0.4 (95% CI -0.4 to 1.2). The main reason for this heterogeneity was the Hussein 2015 study. As indicated in the short-term effects following stretch section, this study had very large, implausible effects so we decided to omit it from the analysis. Therefore three studies with a total of 268 participants were included in the analyses (Jerosch-Herold 2011; Jongs 2012; Moseley 2005). The participants included people with ankle fracture, Dupuytren's contracture and wrist fracture. The SMD was -0.1 (95% CI -0.3 to 0.2; I^2 = 0%; P = 0.49) (see Analysis 7.2).

Participation restrictions

Short-term effects following stretch

Neurological conditions

One study with a total of 58 participants investigated the short-term effects on participation restrictions following stretch in people with neurological conditions (Harvey 2006). This study did not provide sufficient data.

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Non-neurological conditions

Two studies with a total of 129 participants investigated the short-term effects on participation restrictions following stretch in people with non-neurological conditions (Jongs 2012; Moseley 2005). Both studies provided sufficient data. The participants included people with ankle and wrist fracture. The SMD was -0.2 (95% CI -0.6 to 0.1; I^2 = 0%; P = 0.21) (see Analysis 8.1; Summary of findings 2). The GRADE quality of evidence for this result was low.

Long-term effects following stretch

Neurological conditions

No study measured a participation restriction outcome during this time period.

Non-neurological conditions

Two studies with a total of 122 participants investigated the long-term effects on participation restrictions following stretch in people with non-neurological conditions (Jongs 2012; Moseley 2005). Both studies provided sufficient data. The participants included people with ankle and wrist fracture. The SMD was -0.2 (95% CI -0.6 to 0.3; I^2 = 26%; P = 0.50) (see Analysis 9.1).

Spasticity

Short-term effects following stretch

Neurological conditions

Seven studies with a total of 159 participants investigated the short-term effects on spasticity following stretch in people with neurological conditions (Basaran 2012; Burge 2008; Copley 2013; De Jong 2006; Hill 1994; Lai 2009; Lannin 2007a). Six studies with a total of 144 participants provided sufficient data (Basaran 2012; Burge 2008; Copley 2013; De Jong 2006; Lai 2009; Lannin 2007a). The participants included people with stroke and acquired brain injury. The SMD was 0.0 (95% CI -0.3 to 0.4; I^2 = 0%; P = 0.85) (see Analysis 10.1).

Non-neurological conditions

No study measured a spasticity outcome during this time period as spasticity is not relevant to this group.

Long-term effects following stretch

Neurological conditions

Three studies with a total of 73 participants investigated the long-term effects on spasticity following stretch in people with neurological conditions (Ackman 2005; Copley 2013; Lannin 2007a). All studies provided sufficient data. The participants included people with stroke, cerebral palsy and acquired brain injury. The SMD was -0.3 (95% CI -0.8 to 0.1; I^2 = 0%; P = 0.16) (see Analysis 11.1).

Non-neurological conditions

No study measured a spasticity outcome during this time period as spasticity is not relevant to this group.

Adverse events

Neurological conditions

Five studies with a total of 145 participants provided statements about adverse events (Ackman 2005; Horsley 2007; Fox 2000; Rose 2010; Turton 2005). However, the data were not sufficiently detailed or comparable to analyse quantitatively. The details of the adverse events described in the five studies are:

- Ackman 2005 stated that there were no adverse events directly related to the experimental intervention (plaster cast) but three children from the experimental group withdrew from the study because their parents felt they were tripping and falling more than usual.
- Fox 2000 and Rose 2010 reported five adverse events, including skin breakdown, mild bruising, and a blister on a toe. These adverse events were thought to be due to the intervention (application of plaster casts).
- Horsley 2007 reported one death in the control group. It is very unlikely the death was caused by the intervention.
- Turton 2005 stated that three participants ceased the intervention because of shoulder pain (n = 1) or wrist pain (n = 2). It is not clear if these adverse events were caused by the intervention.

Non-neurological conditions

Nine studies with a total of 635 participants included statements about adverse events (Horton 2002; Jerosch-Herold 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lee 2007; Paul 2014; Seeger 1987; Zenios 2002). Two studies (Kolmus 2012; Paul 2014) explicitly stated that there were no adverse events. One study (Jerosch-Herold 2011) indicated that some participants did not comply with the experimental intervention because of discomfort,

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pain, sleep disturbance, a rash or stiffness but did not provide any further details. The data from the remaining six studies were not sufficiently detailed or comparable to analyse quantitatively. The details of the adverse events described in the six studies are:

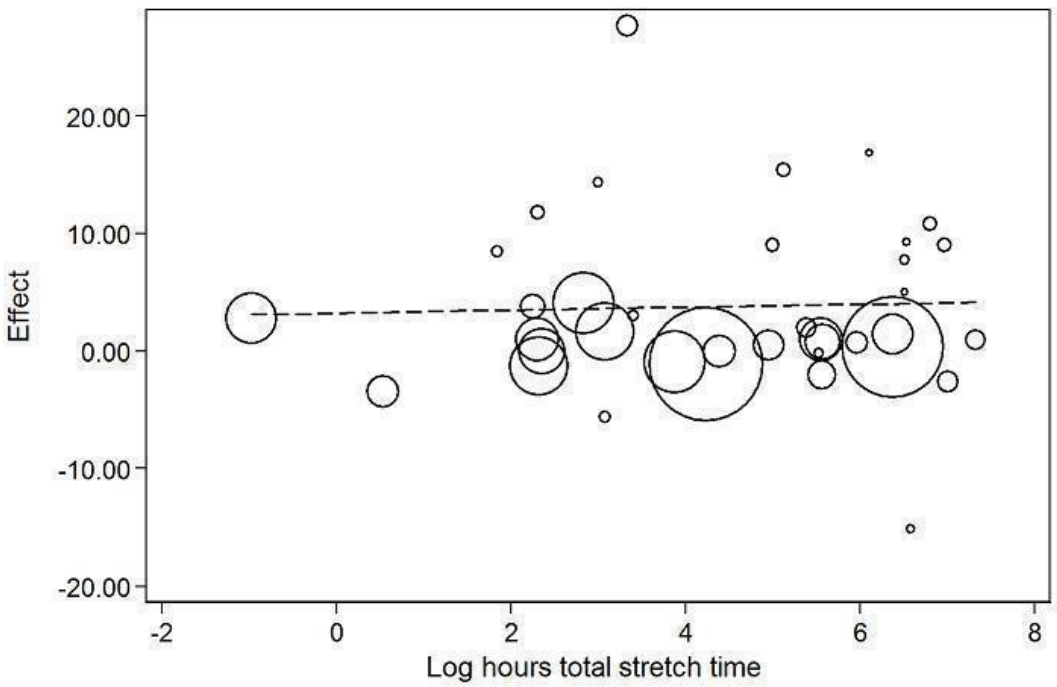
- Horton 2002 reported one adverse event in a control participant (haematoma) and three adverse events in participants receiving the intervention (one deep venous thrombosis, one death and one requiring manipulation under anaesthesia).
- Jongs 2012 stated that some participants in the intervention group experienced transient numbness (n = 10) or pain (n = 1) due to the splint. It is not clear if adverse events were monitored in the control participants.
- Kemler 2012 reported 14 adverse events in experimental participants (haematoma = 5; flexion deficits = 8) and eight adverse events in control participants (haematoma = 4; flexion deficits = 4).
- Lee 2007 reported swelling in control (n = 4) and intervention participants (n = 1).
- Seeger 1987 stated that four participants in the intervention group dropped out because of exacerbation of Raynauds' phenomenon due to the splint. It is not clear if adverse events were monitored in the control participants.
- Zenios 2002 reported wound infections in control (n = 1) and intervention participants (n = 10).

Subgroup analyses

The effects of different stretch dosages on joint mobility (total stretch time)

Thirty seven studies with a total of 1519 participants measured joint mobility in degrees and provided sufficient data to estimate the effect of mean total stretch time on joint mobility (Ackman 2005; Ada 2005; Aoki 2009; Basaran 2012; Collis 2013; Copley 2013; Ben 2005; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Horsley 2007; Horton 2002; Hussein 2015; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lannin 2003a; Lannin 2007a; Lee 2007; McNee 2007; Moseley 1997; Moseley 2005; Paul 2014; Refshauge 2006; Seeger 1987; Steffen 1995; Turton 2005; Zenios 2002). As mean time data were skewed, they were transformed by taking the natural logarithm of time. We adjusted total stretch time for the length of time between randomisation and measurement as well as the length of time between the last stretch and measurement using multiple meta-regression. The MD was 0° for each log hour increase in total stretch time (95% CI -1 to 1; I^2 = 31%; P = 0.119) (see Figure 6).

Figure 6. Bubble plot of meta-regression analysis: Joint mobility - effects of total stretch time on joint mobility - all conditions (degrees)



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The effects of different stretch interventions on joint mobility

Thirty seven studies with a total of 1530 participants measured joint mobility in degrees and provided sufficient data to estimate the effect of different stretch interventions on joint mobility (Ackman 2005; Ada 2005; Aoki 2009; Basaran 2012; Collis 2013; Copley 2013; Ben 2005; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Horsley 2007; Horton 2002; Hussein 2015; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lannin 2003a; Lannin 2007a; Lee 2007; McNee 2007; Moseley 1997; Moseley 2005; Paul 2014; Refshauge 2006; Seeger 1987; Steffen 1995; Turton 2005; Zenios 2002). We examined the overall effect of administering stretch in five different ways: serial casting; positioning; splinting; self-administration; and other ways. The effect of stretch on joint mobility was not influenced by the way stretch was administered (test for subgroup differences; P = 0.33) although these results need to be interpreted with caution because some subgroups only included two studies.

Three studies with a total of 57 participants investigated the effect of serial casting on joint mobility (Ackman 2005; McNee 2007; Moseley 2005). The MD of serial casting on joint mobility was 5° (95% CI -3 to 12; I^2= 65%; P = 0.21) (see Analysis 12.1).

Seven studies with a total of 165 participants investigated the effect of positioning on joint mobility (Ada 2005; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Jang 2015; Turton 2005). The MD of positioning on joint mobility was 3° (95% CI -3 to 8; I^2 = 40%; P = 0.32) (see Analysis 12.1).

Eighteen studies with a total of 847 participants investigated the effects of splinting on joint mobility (Basaran 2012; Collis 2013; Copley 2013; Harvey 2006; Horton 2002; Hussein 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lannin 2003a; Lannin 2007a; Refshauge 2006; Seeger 1987; Steffen 1995; Zenios 2002). There was substantial statistical heterogeneity between studies (I^2 = 97%). The main reason for this heterogeneity was the Hussein 2015 study. As indicated in the short-term effects following stretch section, this study had very large, implausible effects so we decided to omit it from the analysis. Therefore 17 studies with a total of 787 participants were included in the analyses (Basaran 2012; Collis 2013; Copley 2013; Harvey 2006; Horton 2002; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lannin 2003a; Lannin 2007a; Refshauge 2006; Seeger 1987; Steffen 1995; Zenios 2002). The MD of splinting on joint mobility was 0° (95% CI -1 to 2; I^2 = 28%; P = 0.68) (see Analysis 12.1 and Figure 7).

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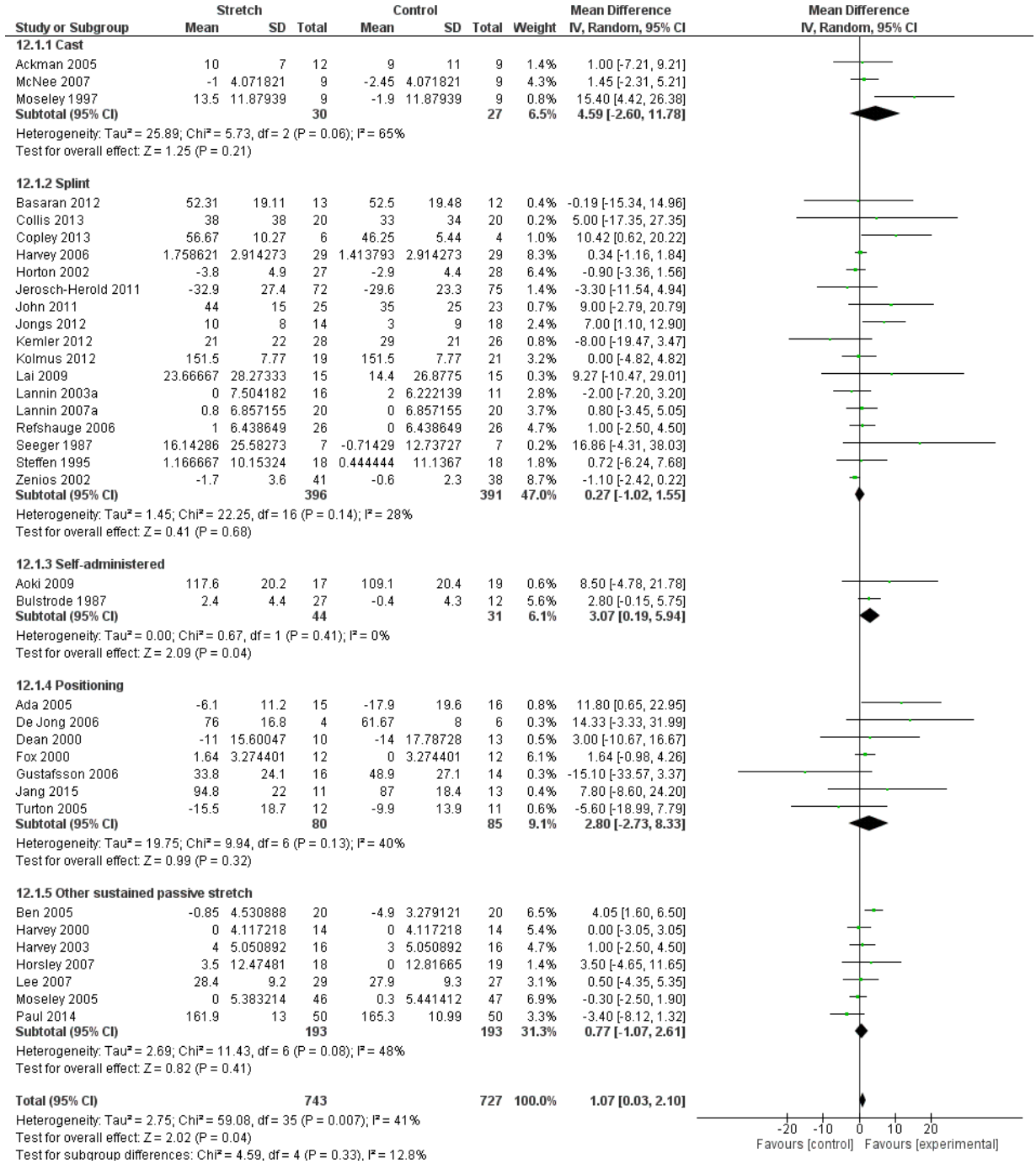
Figure 7. Forest plot of comparison: Joint mobility - subgroup analyses by type of stretch intervention - neurological conditions (degrees)



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Two studies with a total of 75 participants investigated the effects of self-administered stretches on joint mobility (Aoki 2009; Bulstrode 1987). The MD of self-administered stretches on joint mobility was 3° (95% CI 0 to 6; I^2 = 0%; P = 0.04) (see Analysis 12.1 and Figure 7).

Seven studies with a total of 386 participants investigated the effects of other stretch interventions on joint mobility (Ben 2005; Harvey 2000; Harvey 2003; Horsley 2007; Lee 2007; Moseley 2005; Paul 2014). The MD of other stretch interventions on joint mobility was 1° (95% CI -1 to 3; I^2 = 48%; P = 0.41) (see Analysis 12.1 and Figure 7).

The effects of stretch on joint mobility in small joints versus large joints

Thirty seven studies with a total of 1506 participants measured joint mobility in degrees and provided sufficient data to estimate the effects of stretch in small versus large joints (Ackman 2005; Ada 2005; Aoki 2009; Basaran 2012; Collis 2013; Copley 2013; Ben 2005; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Horsley 2007; Horton 2002; Hussein 2015; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lannin 2003a; Lannin 2007a; Lee 2007; McNee 2007; Moseley 1997; Moseley 2005; Paul 2014; Refshauge 2006; Seeger 1987; Steffen 1995; Turton 2005; Zenios 2002). The effect of stretch on joint mobility was not influenced by the size of the joint (test for subgroup differences; P = 0.42).

Twenty studies with a total of 822 participants investigated the effects of stretch in small joints (Ackman 2005; Ben 2005; Basaran 2012; Collis 2013; Copley 2013; Harvey 2000; Harvey 2006; Horsley 2007; Jerosch-Herold 2011; Lannin 2003a; Lannin 2007a; John 2011; Jongs 2012; Kemler 2012; McNee 2007; Moseley 1997; Moseley 2005; Refshauge 2006; Seeger 1987; Turton 2005). The MD of stretch in small joints was 1° (95% CI 0 to 3; I^2 = 45%; P = 0.07) (see Analysis 12.2).

Seventeen studies with a total of 705 participants measured joint mobility in degrees and provided sufficient data to estimate the effects of stretch in large joints (Aoki 2009; Ada 2005; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Harvey 2003; Horton 2002; Hussein 2015; Jang 2015; Kolmus 2012; Lai 2009; Lee 2007; Paul 2014; Steffen 1995; Zenios 2002). There was substantial statistical heterogeneity between studies (I^2 = 97%). The main reason for this heterogeneity was the Hussein 2015 study. As indicated in the short-term effects following stretch section, this study had very large, implausible effects so we decided to omit it from the analysis. Therefore 16 studies with a total of 645 participants were included in the analyses (Aoki 2009; Ada 2005; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Harvey 2003; Horton 2002; Jang 2015; Kolmus 2012; Lai 2009; Lee 2007; Paul 2014; Steffen 1995; Zenios 2002). The MD of splinting on joint mobility was 1° (95% CI -1 to 2; I^2 = 36%; P = 0.44) (see Analysis 12.2).

The effects of stretch on joint mobility when influenced by participants' perceptions of discomfort

Thirty-seven studies with a total of 1506 participants measured joint mobility in degrees and provided sufficient data to estimate the effects of stretch when measurements could be influenced by participants' perceptions of discomfort versus when measurements could not be influenced by participants' perceptions of discomfort (Ackman 2005; Ada 2005; Aoki 2009; Basaran 2012; Collis 2013; Copley 2013; Ben 2005; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Harvey 2000; Harvey 2003; Harvey 2006; Horsley 2007; Horton 2002; Hussein 2015; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lannin 2003a; Lannin 2007a; Lee 2007; McNee 2007; Moseley 1997; Moseley 2005; Paul 2014; Refshauge 2006; Seeger 1987; Steffen 1995; Turton 2005; Zenios 2002). The effect of stretch on joint mobility was not influenced by participants' perceptions of discomfort (test for subgroup differences; P = 0.90).

Twenty-six studies with a total of 1069 participants used methods where joint mobility measurements could be influenced by participants' perceptions of discomfort (e.g. studies that measured maximal passive or active joint range of motion) (Ackman 2005; Ada 2005; Aoki 2009; Basaran 2012; Collis 2013; Copley 2013; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Horton 2002; Hussein 2015; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lee 2007; McNee 2007; Paul 2014; Seeger 1987; Turton 2005; Zenios 2002). There was substantial statistical heterogeneity between studies (I^2 = 95%) and the SMD was 7° (95% CI 1° to 10°). The main reason for this heterogeneity was the Hussein 2015 study. As indicated in the short-term effects following stretch section, this study had very large, implausible effects so we decided to omit it from the analysis. Therefore 25 studies with a total of 1009 participants were included in the analyses (Ackman 2005; Ada 2005; Aoki 2009; Basaran 2012; Collis 2013; Copley 2013; Bulstrode 1987; De Jong 2006; Dean 2000; Fox 2000; Gustafsson 2006; Horton 2002; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lee 2007; McNee 2007; Paul 2014; Seeger 1987; Turton 2005; Zenios 2002). The MD of stretch on joint mobility when joint mobility measurements could be influenced by participants' perceptions of discomfort was 1° (95% CI 0 to 3; I^2 = 42%; P = 0.14) (see Analysis 12.3).

Eleven studies with a total of 461 participants used methods where

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joint mobility measurements could not be influenced by participants' perceptions of discomfort (e.g. studies that standardised passive joint torque when measuring joint mobility) (Ben 2005; Harvey 2000; Harvey 2003; Harvey 2006; Horsley 2007; Lannin 2003a; Lannin 2007a; Moseley 1997; Moseley 2005; Refshauge 2006; Steffen 1995). The MD of stretch on joint mobility when joint mobility measurements could not be influenced by participants' perceptions of discomfort was 1° (95% CI 0 to 3; I^2 = 46%; P = 0.16).

The effects of stretch on joint mobility for the treatment of contractures versus the prevention of contractures

The distinction between stretch for the treatment and prevention of contractures was often ambiguous. Many studies recruited a mix of participants (that is, some participants had existing contractures whilst other participants were at risk of developing contractures). Only four studies clearly investigated the effects of stretch for the prevention of contractures (that is, participants did not have contractures on entry to the study) (Ada 2005; Copley 2013; Crowe 2000; Melegati 2003). However, only two studies provided sufficient data (Ada 2005; Copley 2013), preventing the planned subgroup analysis.

The effect of stretch on joint mobility when measurements were taken within one day of the last stretch

Studies did not always clearly state the time period between the last stretch and the first post-intervention assessment of joint mobility. This is important because measurements taken within 24 hours of the last stretch may reflect the short-lived viscous effects of stretch. Therefore, when not stated, we assumed that the first post-intervention assessment of joint mobility was taken within 24 hours of the last stretch.

Twenty-eight studies with a total of 1128 participants measured joint mobility in degrees and provided sufficient data to estimate the effects of stretch when measurements were taken less than one day after the last stretch intervention (Ada 2005; Aoki 2009; Basaran 2012; Bulstrode 1987; Collis 2013; Copley 2013; Dean 2000; De Jong 2006; Fox 2000; Gustafsson 2006; Horton 2002; Jang 2015; Jerosch-Herold 2011; John 2011; Jongs 2012; Kemler 2012; Kolmus 2012; Lai 2009; Lannin 2003a; Lannin 2007a; Lee 2007; Moseley 1997; Moseley 2005; Paul 2014; Refshauge 2006; Rose 2010; Seeger 1987; Steffen 1995). The MD was 1° (95% CI 0 to 2; I^2 = 30; P = 0.02) (see Analysis 12.4).

Seven studies with a total of 245 participants measured joint mobility in degrees and provided sufficient data to estimate the effects of stretch when measurements were taken more than one day after the last stretch intervention (Ben 2005; Fox 2000; Harvey 2000; Harvey 2003; Harvey 2006; Horsley 2007; Turton 2005). The MD was 1° (95% CI 0 to 2; I^2 = 31%; P = 0.02) (see Analysis 12.4).

Sensitivity analyses

We conducted sensitivity analyses on the neurological and non-neurological populations to examine the effects of randomisation (adequate sequence generation versus inadequate sequence generation), allocation concealment (concealed versus non-concealed), blinding of assessors (blinding versus no blinding) and completeness of outcome data (complete outcome data available versus incomplete outcome data available) on the primary outcome of joint mobility (details below).

Short-term effects following stretch on joint mobility

Neurological conditions

Excluding studies that did not fulfil the risk of bias criteria (adequate sequence generation, allocation concealment, blinding of assessors and completeness of outcome data) had no effect on the mean difference. We excluded between two and five studies (out of a total of 18 studies) for each of the criteria. We have summarised the results in Table 1 (Additional tables).

Non-neurological conditions

Excluding studies that did not fulfil the risk of bias criteria (adequate sequence generation, allocation concealment, blinding of assessors and completeness of outcome data) had no effect on the mean difference. We excluded between four and eight studies (out of a total of 16 studies) for each of the criteria. We have summarised the results in Table 2 (Additional tables).

Long-term effects following stretch on joint mobility

Neurological conditions

Excluding studies that did not fulfil the risk of bias criteria (adequate sequence generation, allocation concealment, blinding of assessors and completeness of outcome data) had no effect on the mean difference. We excluded between two and three studies (out of a total of eight studies) for each of the criteria. We have summarised the results Table 1 (Additional tables).

Non-neurological conditions

Excluding studies that did not fulfil the risk of bias criteria (adequate sequence generation, allocation concealment, blinding of assessors and completeness of outcome data) had no effect on the mean difference. We excluded between no studies and two studies

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(out of a total of five studies) for each of the criteria. We have summarised the results in Table 2 (Additional tables).

Small sample bias

To examine the possibility of small sample bias in the estimates of the short-term effects of stretch on joint mobility for people with neurological (see Figure 8) and non-neurological conditions (see Figure 9), we generated two funnel plots. Both funnel plots indicated evidence of small sample bias with the effect being greater in the non-neurological conditions than the neurological conditions.

Figure 8. Funnel plot of comparison: 1 Joint mobility - short-term effects following stretch, outcome: 1.1 Neurological conditions (degrees)

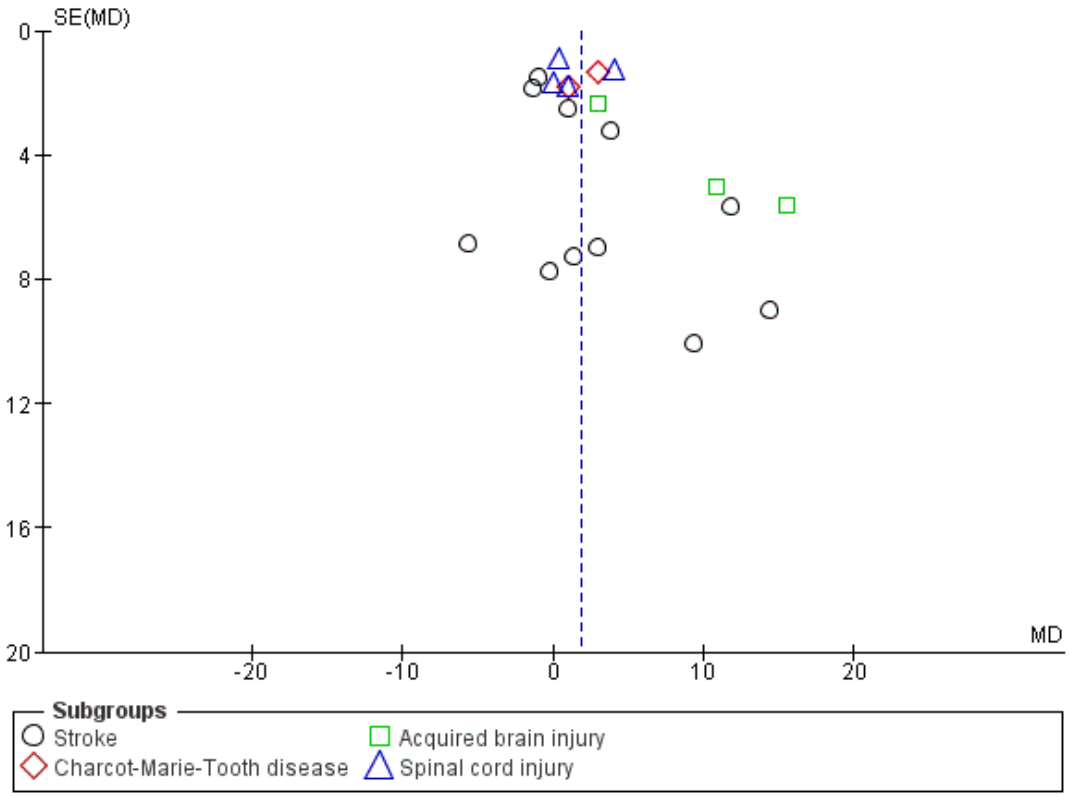

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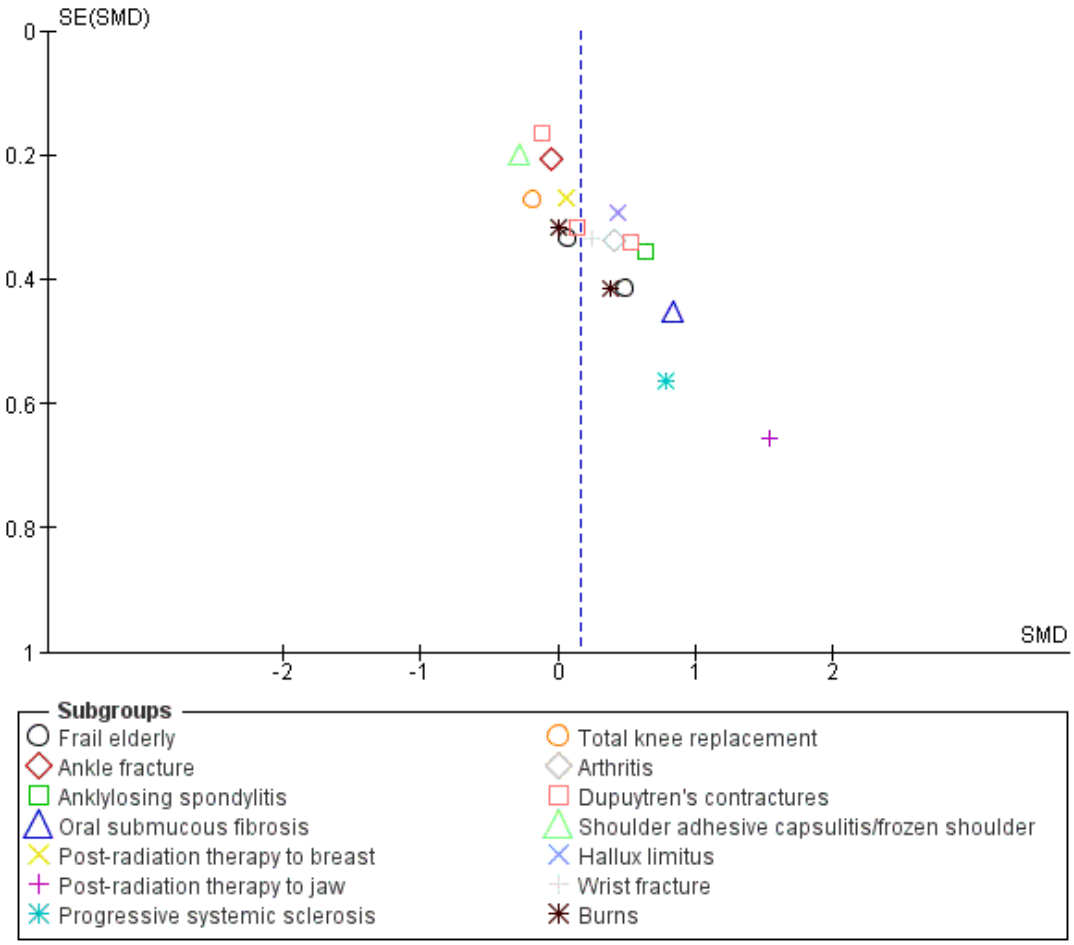
Figure 9. Funnel plot of comparison: 1 Joint mobility - short-term effects following stretch, outcome: 1.2 Non-neurological conditions



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ADDITIONAL SUMMARY OF FINDINGS [*Explanation*]

Short-term effects of stretch for the treatment and prevention of contractures

Patient or population: people with non-neurological conditions[1]
Settings: inpatients and outpatients
Intervention: short-term effects of stretch (< 1 week after the last stretch)

Outcomes	Illustrative comparative risks* (95% CI)		Relative % change (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments, summary statistics and absolute risk difference
	Assumed risk	Corresponding risk				
	Control	Short-term effects of stretch				
Joint mobility Range of motion Scale from 0°-90° (higher number reflects better outcome)	The mean joint mobility in the control groups was **104**°[2]	This translates to an absolute mean increase of 1° higher (0° to 2° higher) compared with control group on a 90° scale[3]		865 (18 studies)	⊕⊕⊕⊕ **high**[4,5]	SMD = 0.2 higher (0.0 to 0.3 higher) Absolute change = 1% better (0% to 2% better) Relative change = 1% better (0% to 2% better) The results rule out a clinically important treatment effect equivalent to 5° and an absolute change and relative change of 5%
Quality of life 160-point Burn Specific Health Scale-Brief questionnaire (higher score reflects better outcome)	The mean quality of life in the control group was **128 points** on a 160-point scale[6]	This translates to an absolute mean increase of 3 (-1 to 6) points compared with control group on a 160-point scale[7]		97 (2 studies)	⊕⊕⊕◯ **moderate**[4,8,9]	SMD = 0.3 higher (0.1 lower to 0.7 higher) Absolute change = 2% better (1% worse to 4% better) Relative change = 2% better (1% worse to 5% better)

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					The results rule out a clinically important treatment effect equivalent to 10 points and an absolute change and relative change of 5%
Pain 10-point VAS (lower score reflects better outcome)	The mean pain in the control group was **4 points** on a 10-point VAS[10]	This translates to an absolute mean decrease of 0.2 (-0.4 to 0.1) points compared with control group on an 10-point scale[11]	422 (7 studies)	⊕⊕⊕⊕ **high**[4,5]	SMD 0.2 lower (0.4 lower to 0.1 higher) Absolute change = 1% better (3% better to 1% worse) Relative change = 2% better (4% better to 1% worse) The results rule out a clinically important treatment effect equivalent to 2 points and an absolute change and relative change of 5%
Activity limitations 100-point Disabilities of the Arm, Shoulder and Hand questionnaire (lower score reflects better outcome)	The mean activity limitation in the control group was **7 points** on a 100-point upper limb scale[12]	This translates to an absolute mean increase of 1.2 (-2.2 to 4.5) points compared with control group on a 100-point scale[13]	356 (5 studies)	⊕⊕⊕⊕ **high**[4,5,8]	SMD = 0.1 higher (0.2 lower to 0.3 higher) Absolute change = 1% better (2% worse to 4% better) Relative change= 8% better (15% worse to 29% better)
Participation restrictions 100 mm return to usual work activities VAS (higher score reflects better outcome)	The mean participant restriction in the control group was **39 points** on a 100-point VAS for return to work activities[14]	This translates to an absolute mean decrease of 11 points (-30 to 6) points compared with control group on a 100-point scale[15]	129 (2 studies)	⊕⊕◯◯ **low**[16,17]	SMD = 0.2 lower (0.6 lower to 0.1 higher) Absolute change = 12% worse (31% worse to 6% better) Relative change = 31%

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					worse (79% worse to 17% better)
Adverse events	Nine studies involving 635 participants reported 41 adverse events that may have been related to the intervention. These included transient numbness (n = 10), pain (n = 1), Raynauds' phenomenon (n = 4), venous thrombosis (n = 1), need for manipulation under anaesthesia (n = 1), wound infections (n = 10), haematoma (n = 5), flexion deficits (n= 8) and swelling (n = 1). These were predominantly from splints	Not estimable	Not estimable	Not estimable	Not estimable

*The **assumed risk** (e.g. the mean control group risk across studies) is based on one representative study chosen on the basis of its size and susceptibility to bias. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio; **VAS**: visual analogue scale

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] All the studies included in this review and included in the 'Summary of Findings' outcomes included people with the following non-neurological conditions: frail elderly and people with ankle fracture, anklylosing spondylitis, oral submucous fibrosis, post-radiation therapy to the breast, post-radiation therapy to jaw, progressive systemic sclerosis, total knee replacement, arthritis, Dupuytren's contractures, shoulder adhesive capsulitis/frozen shoulder, hallux limitus, wrist fracture and burns. An additional study included in this review but not included in the 'Summary of Findings' outcomes included people following anterior cruciate ligament reconstruction. The treatment effects were consistent across all types of non-neurological conditions.

[2] Post data of the control group in Moseley 2005 (the corresponding data in Analysis 1.2 is not post data).

[3] Calculations based on the control group baseline mean (SD) range of motion: 98.4 (5.5) points on a 90-degree range of motion measure (from Moseley 2005).

[4] The quality of evidence was not downgraded due to risk of bias even though at least some of the included trials had selection, performance, detection, attrition and reporting bias. These types of bias would tend to exaggerate treatment effectiveness. Given this review did not demonstrate treatment effectiveness these forms of bias are probably not important.

[5] The quality of the evidence was not downgraded due to indirectness because the results are based on studies involving people with many different types of underlying conditions (e.g. arthritis, frail elderly,ankle fractures).

[6] Post data of the control group in Kolmus 2012 (see Analysis 3.1).
[7] Calculations based on the control group post mean (SD) quality of life: 123 (9) on the 160-point Burn Specific Health Scale Brief (no study provided baseline mean (SD) data for quality of life) (from Kolmus 2012).
8 The quality of the evidence was not downgraded due to imprecision because the point estimate is reasonably precise if expressed as relative % change and absolute risk difference.
[9] The quality of the evidence was downgraded due to indirectness because the results are based on only two studies involving people with burns and post radiation therapy to the breast thereby limiting their generalisability.
[10] Post data of the control group in Paul 2014 (see Analysis 4.1).
[11] Calculations based on the control group baseline mean (SD) pain: 8.0 (0.8) on a 10-point pain scale (from Paul 2014).
[12] Post data of the control group in Jerosch-Herold 2011 (see Analysis 6.2).
[13] Calculations based on the control group baseline mean (SD) activity limitation: 15.4 (13.2) on a 100-point scale (from Jerosch-Herold 2011).
[14] Post data of the control group in Moseley 2005 (see Analysis 8.1).
[15] Calculations based on the control group baseline mean (SD) participation restriction: 39.0 (54.1) on a 100-point scale (from Moseley 2005).
[16] The quality of the evidence was downgraded due to indirectness because the results are based on only two studies involving people with ankle and wrist fracture thereby limiting their generalisability.
[17] The quality of the evidence was downgraded due to imprecision because the point estimates are imprecise if expressed as relative % change or absolute risk difference.

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DISCUSSION

Summary of main results

The primary objective of this systematic review was to determine whether stretch increases joint mobility in people with existing contractures or those at risk of developing contractures. The results provided high-quality evidence that stretch did not have a clinically important short-term effect on joint mobility in people with or without neurological conditions. Similarly, there was no evidence of a long-term effect of stretch. These findings were robust in most sensitivity and sub-group analyses. This systematic review also provides moderate- and high-quality evidence that stretch did not have clinically important short-term effects on quality of life or pain, respectively, in people with non-neurological conditions. The short- and long-term effects of stretch on quality of life and pain in people with neurological conditions were uncertain. There was little or no evidence about the short or long-term effects of stretch on activity limitations or participation restrictions in people with or without neurological conditions but there was initial evidence to indicate that stretch did not have a short-term effect on spasticity in people with neurological conditions (see Table 3 for a summary of the interpretation of all results). There was no useable data to determine the possible adverse events of stretch for people either with or without neurological conditions.

The studies in this review included a diverse group of people with conditions such as spinal cord injury, acquired brain injury, stroke, ankylosing spondylitis, oral submucous fibrosis, systemic sclerosis, ankle fracture and arthritis. The studies were categorised into neurological and non-neurological conditions. We reasoned that it was justified to pool data across these two populations because (a) stretch is used in routine clinical practice in a similar manner across a range of different conditions, and (b) there was relatively little between-study heterogeneity of estimates of effect. We separated neurological from non-neurological conditions to guard against the possibility that involvement of the nervous system, and specifically spasticity, influences the response of people to stretch. The results of the sub-group analyses suggest that the response of different groups of people to stretch is remarkably consistent with little evidence that stretch has a differing effect on joint mobility for people with different types of neurological (see subgroup analyses in Analysis 1.1; Analysis 2.1) or non-neurological conditions (see subgroup analyses in Analysis 1.2; Analysis 2.2). The only exception was acquired brain injury which we discuss below.

The point estimates for the short- or long-term effects of stretch on joint mobility in people with neurological conditions are very small and precise (mean difference (MD) 2°; 95% confidence interval (CI) 0 to 3; and MD 1°; 95% CI -1 to 3, respectively) (see Summary of findings for the main comparison; Summary of findings 2). The precision around both estimates indicates that any possible treatment effect is not greater than 4°. Most would not consider a treatment effect of less than 5° (Ben 2005; Harvey 2000; Harvey 2003; Harvey 2006; Lannin 2003a; Lannin 2007a; Moseley 2005; Refshauge 2006) or even less than 10° (Dean 2000; Gustafsson 2006; Horsley 2007; Lee 2007) as clinically important. The inconsequential size of possible treatment effects are also evident when the results are expressed as absolute change (MD 1%; 95% CI 0 to 2; see Summary of findings for the main comparison). The results are very similar for all sub-group analyses with the exception of acquired brain injury. The point estimates for both the short-term and long-term effects of stretch for people with acquired brain injury are very imprecise failing to rule in or rule out a clinically important treatment effect. However, the results of these sub-group analyses need to be interpreted with caution because the point estimate describing the long-term effect is only based on one study (Copley 2013) of 10 people and this study is highly susceptible to bias (see Figure 2). The point estimate for the short-term effects is based on three studies, however one study is vulnerable to bias (Copley 2013) and another study measured joint mobility immediately after the removal of a plaster cast. The measurement of joint mobility immediately after the removal of a cast may only reflect viscous deformation and may not indicate any therapeutic effect on contracture management (Weppler 2010).

The point estimates describing the short- or long-term effects of stretch on joint mobility in people with non-neurological conditions are more difficult to interpret because not all studies measured joint mobility in degrees and consequently the results are expressed as standardised mean differences (SMD). Nonetheless, there is no indication of a short-term or long-term treatment effect (SMD 0.2; 95% CI 0 to 0.3; SMD -0.1; 95% CI -0.4 to 0.2, respectively). This is also evident when the results are expressed as absolute change. For example, the mean (95% CI) absolute change for the short-term effect of stretch is 1% (0 to 3; see Summary of findings 2).

There is moderate-quality evidence to indicate that stretch has no short-term effects on quality of life for people with non-neurological conditions. No study has examined the long-term effects although it is unlikely that there would be long-term effects if there were no short-term effects. No study has examined the short- or long-term effect of stretch on quality of life in people with neurological conditions.

A secondary purpose of this systematic review was to determine the effect of stretch on pain. There is high-quality evidence to suggest that stretch has no short-term effects on pain in people with non-neurological conditions (SMD -0.2; 95% CI -0.4 to 0.1) (see Summary of findings for the main comparison). The long-term effects of stretch on pain in people with non-neurological conditions and the short- and long-term effects of stretch on pain in people with neurological conditions are less clear, failing to rule in or rule out a possible therapeutic effect.

Stretch is sometimes administered to decrease spasticity in people with neurological conditions. Spasticity is believed to contribute to loss of joint mobility as well as directly interfere with attempts at movement. However, spasticity is notoriously difficult to quantify in clinical studies. Typically it is measured with the Ashworth

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or Tardieu scales (Bohannon 1987; Tardieu 1954). Only six and three studies provided useable data to determine the short-term and long-term effects of stretch on spasticity, respectively. These studies failed to rule in or rule out a possible therapeutic effect however none specifically included people with spasticity. We do not know the effects of stretch from studies that restrict inclusion to those with problematic spasticity.

The effects of stretch on activity limitations and participation restrictions have not been well investigated. In the few instances where effects on these outcomes were evaluated, there was no clear beneficial effect. This is not altogether surprising given the failure of stretch to increase joint mobility or decrease pain. Without underlying changes at the impairment level, it is difficult to envisage a mechanism whereby stretch could have therapeutic effects on activity limitations and participation restrictions.

The dosage of stretch administered in the included studies was highly variable. We used meta-regression to explore the possibility that total stretch time influences joint mobility. The results indicated that increasing dosages of stretch did not influence joint mobility (mean effect 0° for each log hour increase in total stretch time; 95% CI -1 to 1). We also used meta-analysis to investigate the relative effectiveness of different stretch interventions including serial casting, positioning, splinting, self-administered stretches and other stretches. The data do not support the hypothesis that any particular intervention is superior to another. In addition, there was no evidence that the effects of stretch differed between large and small joints. However, the results of all these meta-analyses and sub-group analyses need to be interpreted with some caution because they are based on non-randomised between-study comparisons, rather than on randomised within-study comparisons, so there is potential for serious confounding.

Overall completeness and applicability of evidence

Most studies only investigated the use of stretch over relatively short time periods of four to 12 weeks. No study investigated the use of stretch over periods greater than seven months. The effectiveness of stretch that is performed for periods longer than seven months remains unknown. It is conceivable that small effects of stretch accumulate over many years. Studies conducted with this time frame will be difficult to conduct and pose a logistic challenge to future researchers, although we did identify one study that is still being conducted that is examining the effect of orthoses worn for one year in children with cerebral palsy (Characteristics of ongoing studies).

Most of the included studies examined the added benefit of stretch over and above the usual care provided to both experimental and control groups. Usual care was rarely defined, but in most studies probably involved comprehensive skin, nursing and in some instances rehabilitation programmes. Stretch may have been administered as participants moved or were moved by others as part of these programmes and as part of routine daily activities. Therefore, while the results of this review indicate that stretch as typically applied by physiotherapists does not produce lasting increases in joint mobility, the effects or possible importance of stretch administered as part of usual nursing care has not been answered in this review. For example, the results of this review do not shed light on the assumed importance of appropriate positioning in bed for people who are paralysed or unconscious. To answer this question, clinical trials comparing nursing care that involves appropriate positioning in bed with nursing care that does not are required. However, these trials are not likely to be conducted because appropriate positioning in bed is now considered standard care.

Quality of the evidence

The risk of bias in the 49 included studies was variable. Some of the more serious risks of bias included the failure to use adequate methods to generate the randomisation sequence (37% of studies), failure to conceal allocation (49% of studies), failure to blind assessors to objective outcomes (27% of studies), and incomplete outcome data (37% of studies). We included results from all studies in the main analyses regardless of quality. When studies at risk of selection, detection or attrition bias were excluded in the sensitivity analyses, there was no or little change in the estimates of the effect of stretch (Table 1; Table 2). This suggests that the main findings are robust.

There is some indication of small study bias (see Figure 8; Figure 9). That is, there is a disproportionate number of smaller studies with positive findings rather than negative findings. This is more pronounced in studies involving people with non-neurological conditions than people with neurological conditions. Small study bias exaggerates treatment effects. Therefore, our results are probably conservative. That is, the size of treatment effects may be even lower than we have reported, particularly for people with non-neurological conditions.

The GRADE methodology indicates that four of our findings are based on high-quality evidence, namely the short-term effects of stretch on joint mobility in neurological conditions, and the short-term effects of stretch on joint mobility, pain and activity limitations in non-neurological conditions (see Summary of findings for the main comparison; Summary of findings 2). In contrast, the quality of the evidence about the short-term effects of stretch on pain and activity limitations in people with neurological conditions is low. The evidence was downgraded for three reasons: (i) some of the included studies had a high risk of bias (ii) the results were only based on studies involving people with stroke and spinal cord injury (iii) the point estimates were imprecise when expressed as a relative percent change (although they were precise when expressed as an absolute change).

In people with non-neurological conditions, the quality of evidence about the short-term effects of stretch on quality of life and participation restrictions is moderate and low, respectively. The

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evidence of stretch on quality of life was downgraded because the results are based on only two studies involving people with burns and post-radiation therapy to the breast. Similarly, the evidence of stretch on participation restrictions in people with non-neurological conditions is low because the results are only based on studies involving people with ankle and wrist fracture and the point estimates are imprecise if expressed as relative percent change or absolute change.

Potential biases in the review process

A common source of bias in systematic reviews is the failure to identify all relevant studies. We attempted to minimise this bias by performing thorough database searches, including studies in all languages, using forward citation tracking and reference list searches of included studies and relevant systematic reviews, and corresponding with authors of included studies. Despite these efforts, bias may have been introduced from failing to identify unpublished studies. We did identify one unpublished study (Evans 1994) and a study which was only reported in a conference proceeding (Krumlinde-Sundholm 2011). We attempted to attain the data from the authors of these two studies without success. Nonetheless, the main findings are probably robust because retrieval bias generally tends to inflate estimates of effects (Dickersin 1993; Egger 1998) and most estimates of effect were small in this review.

Bias may have been introduced by the exclusion of one of the studies (Hussein 2015) from some analyses. This study included people with shoulder adhesive capsulitis. This study was excluded from some analyses because its results were so extreme that they seemed highly implausible. For example, the authors reported a mean between-group difference of 74° in shoulder abduction one year after the end of a four-week intervention involving the application of a splint for up to 1.5 hours per day. This is between 5 and 30 times greater than the results for any other study including studies which only looked at the short-term effects of stretch. There were other aspects of this study that raised concern. For example, the authors claimed a 100% follow-up rate of 60 participants at one year post randomisation. This is possible but unusual. Our attempts to contact the study authors for clarification were unsuccessful. The potential source of bias in this study is not clear although it is noted that the splint used in this study is very costly and raises the question as to whether the study was sponsored by a commercial company (no sponsorship or funding are declared in any of the three papers that report the results of this study).

Bias in this systematic review may have been introduced because four of the six authors of this systematic review have undertaken randomised controlled trials on this topic. To address this issue review authors did not extract data, assess risk of bias or assess the quality of the evidence for studies in which they had been involved. Instead, these tasks were performed by the other two review authors.

Agreements and disagreements with other studies or reviews

A number of systematic reviews have examined the effects of stretch administered in varying ways on joint mobility (Autti-Ramo 2006; Blackmore 2007; Bovend'Eerdt 2008; Hellweg 2008; Lannin 2003b; Lannin 2007b; Pin 2006; Singer 2001; Van Peppen 2004). The conclusions vary, and not surprisingly, systematic reviews that include non-randomised studies (Michlovitz 2004; Mortenson 2003; Teplicky 2002) tend to report more positive results than systematic reviews that do not. Two recent systematic reviews used meta-analysis to estimate the effects of stretch for improving joint mobility after stroke and similar conditions (Borisova 2009; Tyson 2009). The authors concluded that stretch did not improve joint mobility or upper limb function. These findings are in agreement with the findings of our review.

AUTHORS' CONCLUSIONS

Implications for practice

The results of this systematic review are sufficiently robust to indicate that stretch, as typically provided by physiotherapists, does not produce clinically meaningful effects on severity of contractures in people with neurological or non-neurological conditions. The effects of stretch, as typically provided as part of nursing care for people who are paralysed or unconscious, is not known because this review did not compare different types of nursing care. In addition, no study has examined the effects of stretch administered for more than seven months. Therefore, it may be reasonable to administer stretch to people with persistent neurological conditions on a regular basis over the course of their lives in an effort to treat and prevent contractures. However, it is not known if this is effective.

Stretch may have other therapeutic effects although this is unlikely for the following reasons.

- There is high-quality evidence that stretch does not have short-term effects on pain in people with non-neurological conditions. It is therefore unlikely that stretch would have long-term effects on pain. This is consistent with the two studies that examined the long-term effects of stretch on pain; neither demonstrated a long-term reduction in pain.
- The short- and long-term effects of stretch on pain in neurological conditions are uncertain but stretch is unlikely to reduce pain without accompanying effects on joint mobility and spasticity.
- The effects of stretch on quality of life, activity limitations and participation restrictions in people with and without neurological conditions are uncertain, although there is

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moderate-quality evidence to indicate that stretch does not have short-term effects on quality of life in people with non-neurological conditions. While there is not strong evidence about the effects of stretch on these outcomes, it is most unlikely that stretch would have therapeutic effects on any of these outcomes in the absence of an effect on joint mobility, pain or spasticity.

Implications for research

We do not recommend further studies looking at the short-term effects of stretch on joint mobility in either people with neurological or non-neurological conditions because the quality of evidence indicating that stretch is ineffective is high and further studies are unlikely to change these findings. While the quality of evidence about the long-term effects is less rigorous, there is no theoretical basis upon which to believe that stretch may have long-term effects on joint mobility in the absence of a short-term effect. There may be worth in examining the effectiveness of stretch administered with other interventions. For example, stretch administered with motor training or botulinum toxin in people with neurological conditions. There may also be worth in specifically looking at the effectiveness of stretch for the prevention of contracture in those at high risk of developing contracture (e.g. people with traumatic brain injury).

Future research should be directed at clarifying the effects of stretch performed for more than seven months. This research should only be conducted in clinical populations where stretch might routinely be performed over long time periods (for example, people with stroke, spinal cord injuries or cerebral palsy).

We do not recommend further studies to determine the effect of stretch on pain in people with non-neurological conditions but it may be worth clarifying the effect of stretch on pain in people with neurological conditions if there is any theoretic reason to believe that stretch may be therapeutic.

While there is potential for more research on the effect of stretch on quality of life, activity limitations and participation restrictions in people with and without neurological conditions, this area of research may be futile in the absence of accompanying effects of stretch on joint mobility.

Future researchers should strive to improve the quality and reporting of their studies. The use of concealed allocation and blinded assessors is particularly important for reducing bias. The accuracy of future meta-analyses could also be substantially improved if researchers consistently reported between-group differences with associated measures of variability for all outcomes and at all time points of data collection. Future researchers should also clarify whether their studies are directed at the treatment or prevention of contractures. Clear reporting of these characteristics would enable future meta-analysis to be conducted on this topic.

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Original review

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* *Indicates the major publication for the study*

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CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Ackman 2005

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Children with spastic cerebral palsy **Sample size:** Experimental group: 13, Control group: 12, Other group: 14 **Setting, Country:** Outpatient clinics, USA **Joint of interest:** Ankle **Inclusion criteria:** • Diagnosis of spastic hemiplegia or diplegia • Between 3-10 years old • Ambulate independently without assistive devices • Ambulate in functional equinus (toe-toe or heel-toe pattern) • Neutral ankle position with full knee extension **Exclusion criteria:** • Previous orthopaedic surgery to tendo-achilles or sub-talar joint • No botulinum toxin injections in previous 6 months • Hip or knee flexion contractures greater than 10° **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (range):** Experimental group: 6 years (3-8), Control group: 6 years (3-9), Other group: 6 years (3-9) **Gender:** Experimental group: 54% female, Control group: 50% female, Other group: 57% female
Interventions	**Groups included in this review:** ***Experimental group: Botulinum toxin plus cast*** Participants received botulinum toxin injections into gastrocnemius muscle followed by cast for 3 weeks at baseline, 3 months and 6 months. Ankle-foot orthosis (AFO) worn in between casting periods for 20-22 h/d Total stretch time: 24 h x 7 d x 9 weeks = 1512 hours over a 6-month period ***Control group: Botulinum toxin*** Participants received botulinum toxin injections into gastrocnemius muscle at baseline, 3 months and 6 months. AFO worn for 20-22 h/d ***Other group: Placebo plus cast*** Participants received placebo injections into gastrocnemius muscle followed by cast for 3 weeks at baseline, 3 months and 6 months. AFO worn in between casting periods for 20-22 h/d Total stretch time: 24 h x 7 d x 3 weeks = 504 hours over a 3-week period
Outcomes	**Outcomes included in this review:** • Passive ankle dorsiflexion with the knee extended (degrees) • Triceps surae spasticity (Ashworth) **Other outcomes:** Passive ankle dorsiflexion (knee flexed), active ankle dorsiflexion (knee flexed), ankle dorsiflexion at initial contact during gait, peak ankle dorsiflexion during stance, peak ankle dorsiflexion during swing, triceps surae spasticity (Tardieu), walking

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	velocity, stride length, ankle plantarflexion strength, ankle dorsiflexion strength, ankle power generation **Time points included in this review:** Outcomes measured at 12 months **Other time points:** Outcomes also measured at baseline, 3 months, 6 months and 7.5 months
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quote: "...block design randomisation sequence", p 621 Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported. If concealment was used, every third allocation could be determined due to the use of a fixed blocked sequence
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...the children and parents were instructed not to discuss their treatment with the evaluating clinician to ensure that the clinician maintained blinding to the treatment group", p 6
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 5/39 (13%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	High risk	Quote: "...leading to an early termination of the study before obtaining the projected number of children", p 622 Comment: possible cause of bias introduced by early termination of study

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Ada 2005

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 18, Control group: 18 **Setting, Country:** Inpatient rehabilitation units of 4 metropolitan hospitals, Australia **Joint of interest:** Shoulder **Inclusion criteria:** • Experienced first stroke within the previous 20 days • Had hemiplegia • Between 50-80 years old • At risk of developing contracture as a result of having little or no upper limb function - defined as a score of 0-4 on item 6 of the MAS **Exclusion criteria:** • Already had a shoulder problem - defined as pain or loss of greater than 20° of intact shoulder ROM in either external rotation or flexion • Had cognitive problems that precluded them from participating in the positioning programme **Existing contracture, at risk of contracture, or combination of both:** Participants were at risk of developing contracture **Mean age (SD):** Experimental group: 70 years (7), Control group: 64 years (9) **Gender:** Experimental group: 60% female, Control group: 56% female
Interventions	**Groups included in this review:** ***Experimental group: Shoulder positioning and routine care*** Participants received 2 x 30-min sessions of shoulder positioning: Position 1 - participants in supine, 45° shoulder abduction and maximal external rotation Position 2 - participants sitting with arm on table with shoulder flexed to 90° and elbow bent at 90° Participants also received up to 10 min shoulder exercises and routine upper-limb care Total stretch time: 30 min x 5 days x 4 weeks = 10 h for each position over a 4-week period ***Control group: Routine care*** Participants received up to 10 min shoulder exercises and routine upper-limb care ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Maximum passive shoulder external rotation of the affected limb (degrees) • Pain experienced during maximal external rotation (yes/no) • Item 6 MAS (Limits 0-6; 0 = worse, 6 = better) **Other outcomes:** Maximum passive shoulder flexion (affected limb), shoulder contracture in external rotation (as compared to intact limb), shoulder contracture in flexion (as compared to intact limb), pain experienced during maximal flexion **Time points included in this review:** Outcomes measured at discharge (or 4 weeks) - whichever was the sooner **Other time points:** Outcomes also measured at baseline
Notes	
Risk of bias	

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Ada 2005 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: Insufficient detail reported in paper. Author correspondence revealed that the randomisation sequence was computer generated
Allocation concealment (selection bias)	Low risk	Quote: "...centrally randomized into either the experimental or the control group", p 231
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...an assessor blinded to group allocation carried out measurements", p 231
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 5/36 (14%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Aoki 2009

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with knee osteoarthritis **Sample size**: Experimental group: 17 (33 knees), Control group: 19 (33 knees) **Setting, Country**: Outpatient clinic of a large metropolitan hospital, Japan **Joint of interest**: Knee **Inclusion criteria**: • Severe unilateral or bilateral knee osteoarthritis established using radiography • Planning to undergo total knee arthroplasty **Exclusion criteria**: • Could not follow instructions • Could not lie prone • Self-reported severe cardiovascular disease, neurological disease, or lower limb disorders other than knee osteoarthritis **Existing contracture, at risk of contracture, or combination of both**: Participants

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	had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 72 years (5), Control group: 74 years (6) **Gender**: Experimental group: 100% female, Control group: 100% female
Interventions	**Groups included in this review:** ***Experimental group*** **:** ***Home-based stretch*** Participants self-administered two knee flexion stretches (sitting on the floor and prone) Total stretch time[1]: 5 min x 7 d x 11.6 weeks = 6.7 h over a 3-month period ***Control group*** **:** ***Maintain usual physical activity*** Instructed to maintain their current level of physical activity ***Other groups*** **:** Nil
Outcomes	**Outcomes included in this review:** • Knee ROM in supine (degrees) • Gait speed (m/min) • Pain during gait (VAS) **Other outcomes**: Knee ROM during gait **Time points included in this review**: Outcomes measured at time of admission (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	[1]The mean duration of treatment (81 days) was used to estimate the total stretch time for the Experimental group. Also assumed that participants performed 10 repetitions each day, not 10 repetitions of each exercise (20 repetitions)

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quote: "…they were randomly allocated to stretching … and control groups", p 114 Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Quote: "*…they were randomly allocated to stretching … and control groups*", p 114 Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "S-ROM was measured by a physiotherapist blinded to the participants", p 115
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants

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Aoki 2009 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Comment: Insufficient detail reported
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes stated were reported
Other bias	High risk	Comment: More than one joint per participant but authors have not adequately accounted for this in the analysis

Basaran 2012

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with stroke **Sample size**: Experimental group: 13, Control group: 13, Other group: 13 **Setting, Country**: Rehabilitation department in a university hospital, Turkey **Joint of interest**: Wrist **Inclusion criteria**: • History of a single stroke • Wrist Modified Ashworth Scale score ≥1+ **Exclusion criteria**: • Cognitive impairment (determined by Mini-Mental State Examination) • Behavioural disturbances • Severe chronic disease likely to interfere with co-operation • Cutaneous or joint pathologies in the upper limb preventing splinting • Previous splinting of the upper limb within the last 8 weeks • If taking antispasticity medication, dosage change in the last month **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 55 years (12) Control group: 60 years (10), Other group: 52 years (11) **Gender**: Experimental group: 46% female, Control group: 42% female, Other group: 38% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Volar splint and home-based exercise programme*** Participants wore each night a custom-made static volar splint (thermoplastic resin with plastazote on the inner surface) with the hand positioned beyond the angle of 'catch' Participants also did home-based exercise programme (details below) Total stretch time: 10 hx 7 d x 5 weeks = 350 h over a 1.25-month period ***Control group : Home-based exercise programme only*** Participants stretched the wrist and finger flexors plus practiced reaching and grasping an object, 10 repetitions of each 3 x d. In addition they were instructed to use their hands as much as possible during daily activities ***Other group : Dorsal splint and home-based exercise programme*** Custom-made static dorsal splint (thermoplastic resin with plastazote on the inner surface) with the hand positioned beyond the angle of 'catch' worn overnight

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	Total stretch time: 8 h x 7 d x 5 weeks = 280 h over a 1.25-month period
Outcomes	**Outcomes included in this review:** • Passive wrist extension (degrees) • Spasticity (Modified Ashworth Scale) **Other outcomes**: H latency of flexor carpi radialis, Hmax:Mmax ratio of flexor carpi radialis **Time points included in this review**: Outcomes measured at 5 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	Assumed participants wore the splint for 8 h per night when calculating total stretch time

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "…subjects were randomly allocated to control and experimental groups by using a simple randomization process (computer-generated random numbers) after baseline measurements", p 330
Allocation concealment (selection bias)	Low risk	Quote: "An independent person was responsible for randomization and group assignment", p 330
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	High risk	Quote: "Measurements associated with electroneuromyography (ENMG) were blinded ...but the others were not", p 331-2 Comment: Range of motion and spasticity measurements were not blinded
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 1/39 (3%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes stated were reported

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Basaran 2012 (*Continued*)

Other bias	Low risk	Comment: Appears to be free of other bias

Ben 2005

Methods	**Design:** Randomised within-subjects study
Participants	**Health condition:** Adults with spinal cord injury **Sample size:** Experimental group: 20 legs, Control group: 20 legs **Setting, Country:** Inpatient rehabilitation unit, Australia **Joint of interest:** Ankle **Inclusion criteria:** • Sustained a spinal cord injury within the past 12 months • Commenced sitting out of bed • Less than grade 2/5 strength in the lower limbs **Exclusion criteria:** • History of trauma to the pelvis or legs • Unable to tolerate standing • Likely to be discharged from hospital within 3 months • Thought unlikely to co-operate **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 34 years (15), Control group: 34 years (15) **Gender:** Experimental group: 20% female, Control group: 20% female
Interventions	**Groups included in this review:** ***Experimental group: Weight-bearing and stretch*** Participants were stood on a tilt table with a 15° wedge on a high block placed under the experimental foot Total stretch time: 30 min x 3 d x 12 weeks = 18 h over a 12-week period ***Control group: Non weight-bearing and non stretch*** Participants were stood on a tilt table but with nothing placed underneath the control foot ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive ankle dorsiflexion (torque controlled) **Other outcomes:** Total proximal femur bone mineral density, total proximal femur bone mineral density (% initial), total proximal femur bone mineral density (% loss of control) **Time points included in this review:** Outcomes measured at 12 weeks (≥ 24 h after last intervention) **Other time points:** Outcomes also measured at baseline
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

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Ben 2005 (*Continued*)

Random sequence generation (selection bias)	Low risk	Quote: "...computer-generated random allocation schedule", p 253
Allocation concealment (selection bias)	Low risk	Quote: "...allocations were placed in sealed, opaque, sequentially numbered envelopes. The envelopes were not opened until after the initial tests had been performed", p 253
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...measurements were taken...by an independent ..", p 253
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: No dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Buchbinder 1993

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults post-radiation therapy for the jaw **Sample size:** Experimental group: 9, Control group: 5, Other group: 7 **Setting, Country:** Oral and maxillofacial surgery clinic, USA **Joint of interest:** Mandibular **Inclusion criteria:** • Decreased inter-incisal opening secondary to radiation therapy • Maximum inter-incisal opening of ≤ 30 mm **Exclusion criteria:** • > 5 years since undergoing radiation therapy **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 51 years (14), Control group: 62 years (9), Other group: 59 years (8) **Gender:** Experimental group: 33% female, Control group: 40% female, Other group: 0% female

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Buchbinder 1993 (*Continued*)

Interventions	**Groups included in this review:** ***Experimental group: Therabite System plus unassisted exercise (Group 3)*** Participants used the Therabite System to sustain a maximum comfortable stretch of the jaw. Also performed 10 cycles/d of unassisted exercise - opening to maximal inter-incisal distance, closing, then moving maximally to the left and right and protrusively Total stretch time: 5 x 30 s x (6-10 sessions) x 7 d x 10 weeks = 17.5 h-29.2 h over a 10-week period ***Control group: Unassisted exercise (Group 1)*** Participants performed 10 cycles/d of unassisted exercise - opening to maximal inter-incisal distance, closing, then moving maximally to the left and right and protrusively ***Other group: Stacked tongue depressors plus unassisted exercise (Group 2)*** Participants used stacked tongue depressors to maximally open the mouth. Also performed 10 cycles/d of unassisted exercise - opening to maximal inter-incisal distance, closing, then moving maximally to the left and right and protrusively Total stretch time: 5 x 30 s x (6-10 sessions) x 7 d x 10 weeks = 17.5 h-29.2 h over a 10-week period
Outcomes	**Outcomes included in this review:** • Maximal incisal opening (mm) • Pain rating (scale not reported) • Subjective well-being (scale not reported) **Other outcomes:** Subjective rating of ROM, lateral jaw movements, protrusive jaw movements **Time points included in this review:** Outcomes measured at 10 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline, 2 weeks, 4 weeks, 6 weeks and 8 weeks
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...patients were randomly assigned to one of three groups", p 864 Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Comment: Insufficient detail reported

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Buchbinder 1993 (*Continued*)

Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: No dropouts reported
Selective reporting (reporting bias)	High risk	Comment: Lateral and protrusive jaw movements, pain, subjective ROM, and subjective well-being all listed as outcomes in the methods but no data reported
Other bias	Low risk	Comment: Appears free of other bias

Bulstrode 1987

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with ankylosing spondylitis **Sample size:** Experimental group: 27, Control group: 12 **Setting, Country:** Inpatient hospital, UK **Joint of interest:** Hip **Inclusion criteria:** • Typical radiological features of ankylosing spondylitis • No previous hip surgery **Exclusion criteria:** Nil reported **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: not reported, Control group: not reported **Gender:** Not reported
Interventions	**Groups included in this review:** ***Experimental group: Stretch plus conventional care*** Participants received cycles of 3 contract relax stretches to the hip muscles Total stretch time: not reported ***Control group: Conventional care*** Participants received active exercises in gymnasium and hydrotherapy pool to increase strength and joint mobility ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Hip extension with knee in extension (degrees) **Other outcomes:** Hip flexion, hip extension with knee in flexion, single leg abduction, bimalleolar abduction, medial hip rotation, lateral hip rotation **Time points included in this review:** Outcomes measured at 15 days (end of intervention), 6 months following end of intervention **Other time points:** Outcomes also measured at baseline

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Bulstrode 1987 (*Continued*)

Notes		

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "were allocated at random ... in blocks of nine to give two in the treatment group for every one control", p 40
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...measurements were recorded by an independent assessor who did not know to which group the patients had been allocated", p 40-1
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: No dropouts for 3-week data, 7/39 (18%) dropouts at 6 months No data reported for 6 months
Selective reporting (reporting bias)	High risk	Comment: 6-month joint mobility data were not reported
Other bias	Low risk	Comment: Appears free of other bias

Burge 2008

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 31, Control group: 16 **Setting, Country:** Inpatient rehabilitation unit, Switzerland **Joint of interest:** Wrist **Inclusion criteria:** • Admitted for intensive rehabilitation • No previous stroke • Severe paresis of the upper limb - FMA upper-extremity motor score ≤ 45 points • Sufficient comprehension to participate in trial as assessed by speech therapist

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	Exclusion criteria: • Traumatic injuries • Rheumatic co-morbidities • Lesion of the peripheral nervous system • Other lesions of the central nervous system • Lymphoedema **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 68 years (12), Control group: 64 years (14) **Gender:** Experimental group: 60% female, Control group: 67% female
Interventions	**Groups included in this review:** ***Experimental group: Orthosis plus conventional care*** Participants were issued a thermoplastic customised wrist splint made following biomechanical principles. The wrist was maintained in a neutral position Total stretch time: not reported ***Control group: Conventional care*** 2 sessions of physical therapy/d, 1 session of occupational therapy/d, and, if indicated, neuropsychologic and speech therapy ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Wrist ROM (FMA sub-scale) • Pain (VAS) • Modified Ashworth scale **Other outcomes:** FMA sub-scale for ROM of forearm, FMA sub-scale for ROM of fingers, hand oedema, participant satisfaction with splint **Time points included in this review:** Outcomes measured at 13 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...allocation schedule was computer generated", p 1858
Allocation concealment (selection bias)	Low risk	Quote: "concealed in opaque, consecutively numbered sealed envelopes by a person not otherwise involved in the study", p 1858
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists

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Burge 2008 (*Continued*)

Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "independent blinded assessor however, complete blinding of the assessor to the group assignment proved to be difficult in practice because some patients would spontaneously comment on their splint type", p 1858
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 4/31 (13%) dropouts at 13 weeks
Selective reporting (reporting bias)	High risk	Comment: Insufficient detail reported to include in meta-analysis
Other bias	Low risk	Comment: Appears free of other bias

Collis 2013

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults following surgical release for Dupuytren's contracture **Sample size**: Experimental group: 26, Control group: 30 **Setting, Country**: Hand therapy clinic, New Zealand **Joint of interest**: Hand **Inclusion criteria**: • Surgical release of Dupuytren contracture (any surgery type) • Attended their first postoperative hand therapy appointment within 14 d after surgery **Exclusion criteria**: • K-wiring of the proximal interphalangeal joint during surgery • Inability to comply with hand therapy **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture **Mean age (SD):** Experimental group: 68 years (8), Control group: 67 years (9) **Gender**: Experimental group: 15% female, Control group: 23% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Night extension orthosis plus hand therapy*** Participants wore each night a thermoplastic orthosis that was custom-fabricated (moulded on the dorsum of the hand holding the operated fingers in maximal comfortable extension without placing undue tension on the wound). The orthosis was adjusted to apply greater extension force to the operated fingers if the therapist deemed this necessary. Participants also received hand therapy (details below) Total stretch time: 8 h x 7 d x 12 weeks = 672 h over a 3-month period ***Control group : Hand therapy alone***

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	Participants received a standard hand therapy programme delivered by an occupational therapist, physiotherapist or hand therapist, which could include active tendon gliding ROM exercises, education, wound care, oedema management, scar management, graded return to usual daily activities, passive stretch with or without heat to increase finger extension and/or flexion, intermittent use of daytime finger-based dynamic proximal interphalangeal joint extension orthoses, and grip strengthening ***Other groups*** : Nil
Outcomes	**Outcomes included in this review:** • Active extension of the little finger (sum of metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints; degrees) • Disabilities of the Arm, Shoulder and Hand Outcome Measure (DASH) **Other outcomes**: Active extension of each operated finger, active flexion of each operated finger, distal palmar crease of each operated finger, grip strength of left and right hand **Time points included in this review**: Outcomes measured at 3 months (end of intervention) **Other time points:** Outcomes also measured at before surgery, at the first postoperative hand therapy visit and 6 weeks
Notes	Assumed participants wore the splint for 8 h per night when calculating total stretch time

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "Participants were randomly allocated to 1 of 2 treatment groups ... This occurred at the first postoperative hand therapy appointment by the participant selecting a tag from an envelope with group allocation concealed", p 1286
Allocation concealment (selection bias)	Low risk	Quote: "Participants were randomly allocated to 1 of 2 treatment groups ... This occurred at the first postoperative hand therapy appointment by the participant selecting a tag from an envelope [LH1] with group allocation concealed", p 1286
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Quote: "1 therapist took nearly all of the measurements. When she was unavailable, 2 other therapists, trained by the first to measure uniformly, filled in", p 1287

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Collis 2013 (*Continued*)

		Comment: Insufficient detail reported
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 3/56 (5%) dropouts at 6 weeks and 2/56 (4%) dropouts at 3 months
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	High risk	Comment: Protocol allowed "rescue". Also a unit of analysis issue. Analysed joints

Copley 2013

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with acquired brain injury **Sample size**: Experimental group: 6, Control group: 4 **Setting, Country**: Brain injury and geriatric assessment/rehabilitation units of a major metropolitan hospital, Australia **Joint of interest**: Wrist and fingers **Inclusion criteria**: • Aged 18-80 years • At least 2 months since acquired brain injury • Moderate stiffness in the wrist and/or hand flexor muscles of the affected upper limb/s with a Modified Ashworth Scale rating of 1+ or 2 • Presence of spasticity in the wrist or finger flexor muscles as indicated by a muscle reactivity rating of at least 2 on the Modified Tardieu Scale • No soft tissue contracture in wrist or finger flexor muscles as indicated by the Modified Tardieu Scale **Exclusion criteria**: • Cognitive or behavioural deficits that prevented the provision of informed consent • Cognitive or behavioural deficits that prevented active participation in an upper limb therapy programme **Existing contracture, at risk of contracture, or combination of both**: Participants were at risk of developing contracture **Mean age (SD):** Experimental group: 40 years (16), Control group: 54 years (6) **Gender**: Experimental group: 33% female, Control group: 50% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Splint and standard practice occupational therapy programme*** Participants wore an individualised, thermoplastic resting mitt splint designed to approximate the standard resting position (20° wrist extension) but tailored to place each participant's hypertonic muscle groups on low load, prolonged stretch. The splint was worn for 2-4 h during the day and overnight. Participants also received an occupational

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	therapy programme (details below) Total stretch time: 10 h x 90 d (3 months) = 900 h over a 3-month period ***Control group : Standard practice occupational therapy programme only*** Participants received a standard practice occupational therapy programme as typically provided to people with upper limb hypertonicity (various combinations of movement training, stretches and functional splinting) ***Other groups*** : Nil
Outcomes	**Outcomes included in this review:** • Wrist extension with the fingers extended (degrees) • Finger flexor spasticity (Modified Tardieu Scale) **Other outcomes**: Wrist extension with the fingers flexed, wrist flexor spasticity, wrist flexor muscle stiffness, finger flexor muscle stiffness **Time points included in this review**: Outcomes measured at 3 months (end of intervention period) and 4 months **Other time points:** Outcomes also measured at baseline, 1 month and 2 months
Notes	Assumed participants wore the splint for 10 h per day when calculating total stretch time

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "A random number table was generated by an independent researcher and used to allocate participants to control (no-splint) and experimental (splint) groups", p 888
Allocation concealment (selection bias)	Unclear risk	Quote: "A random number table was generated by an independent researcher and used to allocate participants to control (no-splint) and experimental (splint) groups", p 888 Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "Measures were completed by a blinded assessor", p 888
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants

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Copley 2013 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 3/10 (30%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes stated were reported
Other bias	High risk	Comment: 3 people were included in ITT analysis but not clear how this was done

Cox 2009

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with oral submucous fibrosis **Sample size:** Experimental group: 54, Control group: 23 **Setting, Country:** Hospital, Nepal **Joint of interest:** Jaw/mouth **Inclusion criteria:** • Confirmed oral submucous fibrosis by biopsy • Subjectively reduced oral opening **Exclusion criteria:** • Oral squamous cell carcinoma • Severely restricted oral opening that required surgical treatment **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 36 years (15), Control group: 35 years (13), Other group: 44 years (19) **Gender:** Experimental group: 30% female, Control group: 30% female, Other group: 10% female
Interventions	**Groups included in this review:** ***Experimental group: Physiotherapy (stacked tongue depressors) plus conventional care*** Participants undertook jaw exercises 5 x d in which tongue spatulas were positioned passively between anterior teeth, spatula number determined by comfortable maximal oral opening. The jaws were opened 5 times in each session, and held in position with the teeth resting on the spatulas for 1 min on each occasion. An additional spatula was added every fifth day unless this caused pain in which case the additional spatula was added on the tenth day. Participants also received conventional care Total stretch time: 5 min x 5 sessions x 7 d x 17 weeks = 2975 min = 49.6 h over a 17-week period ***Control group: Conventional care*** Participants were recommended to cease areca nut use, given dietary advice and received conventional care ***Other groups: Hyaluronidase and steroid injections plus conventional care*** Participants received bi-weekly submucosal injections over 4 weeks of hyaluronidase (1500 units) and hydrocortisone (100 mg)

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Cox 2009 (*Continued*)

Outcomes	**Outcomes included in this review:** • Maximal inter-incisal opening (mm) • Mucosal pain (absent, stimulated by eating, spontaneous, constant) **Other outcomes:** Reported areca nut use, progressive involvement of oral mucosa **Time points included in this review:** Outcomes measured at 4 months (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Random numbers were used for assignation", p 221
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Comment: Insufficient detail reported
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 26/54 (48%) dropouts at 4 months
Selective reporting (reporting bias)	High risk	Comment: Insufficient detail reported to include in meta-analysis
Other bias	High risk	Quote: "patients unable to attend bi-weekly injection were assigned for physiotherapy with the next subject assigned for injection"; "control and injection enrolment ceased for ethical reasons when sufficient control patients returned, and injection was recognized as having poor outcomes", p 221

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Crowe 2000

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with spinal cord injury **Sample size:** Experimental group: 18, Control group: 21 **Setting, Country:** Acute hospital, Canada **Joint of interest:** Shoulder **Inclusion criteria:** • Sustained traumatic spinal cord lesion at or above the C8 level • Subjects with incomplete lesions were required to have some degree of motor deficit **Exclusion criteria:** • Sustained fracture(s) scapula, clavicle or acromial head at the time of trauma • Required shoulder immobilisation for any reason following their accident **Existing contracture, at risk of contracture, or combination of both:** Participants were at risk of developing contracture **Mean age (SD):** Experimental group: 34 years (15), Control group: 44 years (19) **Gender:** Experimental group: 11% female, Control group: 10% female
Interventions	**Groups included in this review:** ***Experimental group: Positioning plus conventional care (Group 2)*** Participants received 2 sessions of shoulder positioning: Position 1: participants in supine with their arms placed on padded supporting boards, shoulders abducted to 90° and elbows extended for 30 min Position 2: participants in supine with their shoulders positioned on pillows in 180° flexion and lateral rotation for 15 min If the positions were not tolerated, shorter durations were applied and slowly increased. Participants also received full passive movements on their upper limbs (either passive, active assisted, active or resisted), scapula stretches, modalities and medications as required for shoulder pain Total stretch time: 45 min x 5 d x (2-16 weeks) = 7.5 h-60 h over a 2-16-week period ***Control group: Conventional care (Group 1)*** Participants received full passive movements on their upper limbs (either passive, active assisted, active or resisted), scapula stretches, modalities and medications as required for shoulder pain ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive shoulder abduction (right arm; degrees) • Pain during preceding 24 h (right shoulder; VAS) • Functional Independence Measure **Other outcomes:** Passive shoulder abduction (left arm), passive shoulder flexion (right arm), passive shoulder flexion (left arm), passive shoulder medial rotation (right arm), passive shoulder medial rotation (left arm), passive shoulder lateral rotation (right arm) , passive shoulder lateral rotation (left arm), pain during preceding 24 h (left shoulder), hours sitting in chair **Time points included in this review:** Outcomes measured at 2 weeks[1] **Other time points:** Outcomes also measured at baseline, week 1, week 3, week 4, week 5, week 6, week 7, week 8, week 9, week 10, week 11 and week 12

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Notes	[1]The intervention was ceased early with some participants (from after week 2) while others were treated up until week 12. We included outcomes from week 2 as all participants received at least 2 weeks of stretch

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...patients were randomly assigned (using a random number generator...)", p 268
Allocation concealment (selection bias)	Low risk	Quote: "…and a system of sealed envelopes", p 268 Comment: Insufficient detail reported in paper. Author correspondence revealed that a system of sequentially-numbered, sealed, opaque envelopes was used to conceal allocation
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...data were collected by a single therapist at each site who was blinded to the treatment allocation of the patient", p 269
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Comment: Length of intervention was different for participants, determined by when they were transferred to another facility. Insufficient detail reported to accurately determine dropouts
Selective reporting (reporting bias)	High risk	Comment: Insufficient detail reported to include in meta-analysis
Other bias	High risk	Quote: "...the trial was terminated with 39 subjects after 3 years of data collection", p 272 Comment 1: possible cause of bias introduced by early termination of study Comment 2: No standard treatment protocol for participants as they were given

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		varying amounts of treatment dependent on length of stay

De Jong 2006

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 10, Control group: 9 **Setting, Country:** Rehabilitation unit, Netherlands **Joint of interest:** Shoulder **Inclusion criteria:** • First ever stroke and maximum of 12 weeks post stroke • Medial cerebral artery stroke • No premorbid impairments of the affected arm • No severe shoulder pain • No use of anti-spasticity drugs • No use of pain-reducing drugs except for paracetamol • No planned date of discharge • Able to give written informed consent **Exclusion criteria:** • Subjects with fair to good recovery of the arm (Brunnstrom stages 4, 5 or 6) • Severe neglect (score of greater than 3 zeros on letter cancellation test) • Severe loss of position sense (scores 2 and 3 on thumb finding test) • Cognitive impairment (less than 23 on Mini-Mental State Examination) • Able to prevent contracture by producing voluntary movement (FMA > 18 on the shoulder/elbow/forearm sub-scales) **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 53 years (10.2)[1], Control group: 52 years (8.8)[1] **Gender:** Experimental group: 33% female[1], Control group: 63% female[1]
Interventions	**Groups included in this review:** ***Experimental group: Positioning plus conventional care*** Participant was positioned in supine with arm in maximal shoulder abduction, shoulder external rotation, elbow extension and supination of the forearm that could be tolerated without any pain. The arm was always supported by a pillow and, if necessary, held in position with a sandbag. Participants also received conventional rehabilitation Total stretch time: 30 min x 2 sessions x 5 d x (5-10 weeks) = 25 h-50 h over a 5-10-week period ***Control group: Conventional care*** Participants received conventional rehabilitation ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive shoulder abduction (degrees) • Pain (yes/no) • Spasticity (Ashworth scale)

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	• Arm motor performance (FMA) **Other outcomes:** Passive shoulder flexion, passive shoulder external rotation, passive elbow extension, passive forearm supination, Barthel Index **Time points included in this review:** Outcomes measured at 10 weeks (end of intervention). **Other time points:** Outcomes also measured at baseline and 5 weeks
Notes	[1]Data obtained via correspondence with study author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...an independent person carried out the randomization procedure. The envelopes were shuffled and drawn blindfolded", p 658
Allocation concealment (selection bias)	Low risk	Quote: "...subjects were randomly assigned to one of the two groups using opaque, sealed envelopes...The envelopes were shuffled and drawn blindfolded", p 658
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...the same two raters, unaware of group allocation and not involved in the treatment of subjects, carried out all the measurements", p 658
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 2/19 (11%) dropouts at 5-week outcome assessment, 9/19 (47%) dropouts at 10-week outcome assessment
Selective reporting (reporting bias)	High risk	Comment: Insufficient detail reported on pain to include in meta-analysis
Other bias	High risk	Quote: "...after nearly two years the trial had to be terminated because of set time limits, leaving only 19 subjects who met all inclusion criteria" p 663 Comment 1: Possible cause of bias introduced by early termination of study

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De Jong 2006 (*Continued*)

		Comment 2: Unclear whether the protocol was for a 10-week or 5-week study

Dean 2000

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 14, Control group: 14 **Setting, Country:** Inpatient rehabilitation unit, Australia **Joint of interest:** Shoulder **Inclusion criteria:** • Less than 10 weeks from the onset of stroke • Score of less than 5 on the upper-arm function item of the MAS for stroke • No pre-morbid shoulder pain • No premorbid restriction of shoulder movement • Passive range of shoulder abduction and flexion greater than 90° • Able to comprehend and use a VAS for pain **Exclusion criteria:** • Subjects with a brainstem stroke **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 58 years (13), Control group: 58 years (11) **Gender:** Experimental group: 50% female, Control group: 15% female
Interventions	**Groups included in this review:** ***Experimental group: Shoulder positioning plus conventional care*** Participants received 3 x 20 min sessions of shoulder positioning: Position 1: lying supine, shoulder in maximum tolerable abduction and external rotation, and elbow flexed Position 2: lying supine, shoulder abduction to 90°, maximum tolerable external rotation, and elbow flexed Position 3: sitting, shoulder forward flexed 90°, elbow extension, wrist extension, and a cylinder in hand to provide a web space stretch Participants also received active training of reaching and manipulation tasks Total stretch time: 3 sessions x 20 min x 5 d x 6 weeks = 30 h over a 6-week period ***Control group: Conventional care*** Participants received active training of reaching and manipulation tasks. No formal stretches were applied to the shoulder joint complex ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive shoulder external rotation (degrees) • Pain at rest (VAS) **Other outcomes:** Active shoulder abduction, pain on dressing **Time points included in this review:** Outcomes measured at 6 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline

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Dean 2000 (*Continued*)

Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...random number tables to determine the subject's group allocation", p 36
Allocation concealment (selection bias)	Low risk	Quote: "...group allocation was completed by a person independent of the recruitment process...the recruiter telephoned another person", p 36
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists.
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...measurements were made by an assessor who was blinded to the subject s group allocation", p 37
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 5/28 (18%) dropouts, with four from experimental group
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

DiPasquale-Lehnerz 1994

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with spinal cord injury **Sample size:** Experimental group: 7, Control group: 6 **Setting, Country:** Rehabilitation unit, USA **Joint of interest:** Hand **Inclusion criteria:** • Not reported although study involved only people with C6 tetraplegia **Exclusion criteria:** Nil reported **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture

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	Mean age (range): Experimental group: not reported, Control group: not reported, both groups: 26 years (18-42) **Gender:** Experimental group: not reported, Control group: not reported, both groups: 8% female
Interventions	**Groups included in this review:** ***Experimental group: Positional orthosis plus conventional rehabilitation*** Participants were issued a short opponens or long opponens orthosis, depending on the strength of their wrist extensors. Both orthoses maintained the distal transverse arch and the thumb web space in 35° of CMC abduction, the metacarpophalangeal joint in full extension, and the interphalangeal joint in slight flexion. Participants also received conventional rehabilitation Total stretch time: 8 h x 7 d x 12 weeks = 672 h over a 12-week period ***Control group: Conventional rehabilitation*** Participants received conventional rehabilitation ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive metacarpophalangeal (MCP) extension • Jebsens hand test sub-item - simulated feeding (seconds) **Other outcomes:** Passive MCP flexion, passive proximal interphalangeal (PIP) extension, passive PIP flexion, passive distal interphalangeal (DIP) extension, passive DIP flexion, size of opening the hand when releasing, size of closing the hand with tenodesis, Jebsen hand test - 6 other sub-items, thumb/finger opposition, palmar abduction, passive lateral prehension grasp, wrist extensor strength **Time points included in this review:** Outcomes measured at 12 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline, 4 weeks and 8 weeks
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...subjects were randomly assigned", p 140 Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Comment: Insufficient detail reported

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DiPasquale-Lehnerz 1994 (*Continued*)

Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 4/13 (31%) dropouts
Selective reporting (reporting bias)	High risk	Comment: Not all pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Fox 2000

Methods	**Design:** Randomised cross-over study
Participants	**Health condition:** Elderly nursing-home residents **Sample size:** Experimental group: 9, Control group: 9 **Setting, Country:** Chronic care hospital, Canada **Joint of interest:** Knee **Inclusion criteria**: • No plans for discharge within 6 months • Knee flexion contracture of 10° or greater in at least one leg • Able to tolerate a bed positioning programme and ongoing assessments without severe pain **Exclusion criteria:** • Behavioural problems that prevented adherence to the programme • Receiving the medication baclofen at the time of recruitment **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (range):** Experimental group: not reported, Control group: not reported, both groups: 82 years (71-93) **Gender:** Experimental group: not reported, Control group: not reported, both groups: 63% female
Interventions	**Groups included in this review:** ***Experimental group: Bed positioning programme (low-load prolonged knee stretch)*** [1] Participants were positioned in supine with their knee extended as much as possible. The position was maintained using bed sheets secured under the mattress Total stretch time: 40 min x 4 d x 8 weeks = 21.3 h over an 8-week period ***Control group: No intervention*** [1] Participants received no intervention ***Other groups*** **:** Nil
Outcomes	**Outcomes included in this review:** • Passive knee extension (degrees) • Level of pain (rated by assessor)

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Fox 2000 (*Continued*)

	Other outcomes: Nil **Time points included in this review:** Outcomes measuring combined effect after 8 weeks of stretch (both cross-over periods combined) **Other time points:** Outcomes also measured at baseline, 1 week , 2 weeks, 3 weeks, 4 weeks, 5 weeks, 6 weeks, 7 weeks, 8 weeks (end of first cross-over period), 9 weeks, 10 weeks, 11 weeks, 12 weeks, 13 weeks, 14 weeks, 15 weeks and 16 weeks (end of second cross-over period)
Notes	[1]Only includes details of the first period of the cross-over

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...randomly assigned to 2 groups by a random numbers table", p 365
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...a single rater blinded to the intervention assessed the participants", p 366
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 6/18 (33%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	High risk	Comment: One participant's group allocation was changed to create even group numbers

Gustafsson 2006

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 17, Control group: 17 **Setting, Country:** Inpatient rehabilitation hospital, Australia **Joint of interest:** Shoulder

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	Inclusion criteria: • Admitted for rehabilitation following first time stroke • No previous history of neurological disease • Pain in or injury to the affected shoulder • At least 45° of passive abduction but less than full active flexion in the affected shoulder **Exclusion criteria:** • Complex medical situation • Not admitted for active rehabilitation • More than 100 days from time of stroke to admission to rehabilitation **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 66 years (16), Control group: 67 years (14) **Gender:** Experimental group: 41% female[1], Control group: 40% female[1]
Interventions	**Groups included in this review:** ***Experimental group: Shoulder positioning plus conventional care*** Participants received 2 x 20 min sessions of shoulder positioning: Position 1: sitting with affected shoulder abducted to 90° and fully supported on the surface of a table with the elbow extended and forearm in neutral Position 2: lying in supine with affected shoulder abducted to 90° and in the maximal amount of achievable external rotation, elbow flexed and forearm pronated Participants also received an additional shoulder positioning programme for remainder of days during the intervention period: In sitting: arm positioned on a custom armrest in 10°-15° of shoulder abduction and midway between shoulder external and internal rotation In bed: a pillow was used to support the stroke-affected shoulder in a position midway between external and internal rotation and not horizontally adducted Participants also received 30 min upper limb therapy Total stretch time: 24 h x 30 d[2] = 720 h over a 30-d period ***Control group: Conventional care*** Participants received 30 min upper limb therapy. Participants also used locally fabricated cushion supports for their stroke-affected upper limb when seated and in bed ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive shoulder external rotation (degrees) • Hemiplegic shoulder pain at rest over previous 24 h (VAS) • Functional independence (Modified Barthel Index) **Other outcomes:** Hemiplegic shoulder pain during assessment (Ritchie Articular Index) , hemiplegic shoulder pain with movement (VAS), MAS for stroke **Time points included in this review:** Outcomes measured at discharge (end of intervention) and 6 months following discharge **Other time points:** Outcomes also measured at baseline
Notes	[1]Data obtained via correspondence with study author [2]Length of intervention was calculated as an average of 30 days for the intervention and control groups

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Gustafsson 2006 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "...referred to a random number table to identify the predetermined, random allocation", p 279
Allocation concealment (selection bias)	Low risk	Quote: "...once consent was obtained, the primary investigator referred to a random number table to identify the predetermined, random allocation of that participant to either the treatment or comparison group", p 279 Comment: Author correspondence revealed that central allocation was used. The person recruiting participants did not have access to the random number table
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	High risk	Quote: "...a blinded assessor completed the measurement of the dependent variables at admission and discharge from rehabilitation", p 279 Quote: "...follow-up assessments were completed by the principal investigator", p 163 in follow-up paper Comment: Blinded assessor for discharge outcomes. Non-blinded assessor for 6 month follow-up outcomes
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 2/17 (12%) dropouts in control group, no dropouts in experimental group
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Unclear risk	Comment: It was identified that 38 people would be needed in the power analysis but only 34 were recruited. Author correspondence revealed that the study was stopped

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		due to participant recruitment difficulties

Harvey 2000

Methods	**Design:** Randomised within-subjects study
Participants	**Health condition:** Adults with spinal cord injury **Sample size:** Experimental group: 14 legs, Control group: 14 legs **Setting, Country:** 2 spinal injury rehabilitation units, Australia **Joint of interest:** Ankle **Inclusion criteria:** • Participating in a rehabilitation programme • Sustained a spinal cord injury within the preceding year • Have not more than grade 1 of 5 motor strength around both ankles • Be willing to cease assisted-standing and all passive exercises and stretches to their ankles for the duration of the study **Exclusion criteria:** • Pressure sores on their heels that prevented stretching or testing • Considered unlikely to co-operate **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 36 years (16), Control group: 36 years (16) **Gender:** Experimental group: 0% female, Control group: 0% female
Interventions	**Groups included in this review:** ***Experimental group: Stretch*** Participants received a constant stretch on the experimental ankle into dorsiflexion with the knee extended using a purpose-built device Total stretch time: 30 minutes x (5 - 7 days) x 4 weeks = 10 hours to 14 hours over a 4-week period ***Control group: Non-stretch*** Participants did not receive any type of manual therapy to either ankle nor did they stand or walk ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Ankle angle at 10 Nm torque with the knee extended (degrees) **Other outcomes:** Ankle angle at 10 Nm torque with the knee flexed, ankle mobility with knee extended (slope of torque/angle curve), ankle mobility with knee flexed (slope of torque/angle curve), baseline ankle angle with knee extended, baseline ankle angle with knee flexed **Time points included in this review:** Outcomes measured at 4 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline, 2 weeks and 5 weeks
Notes	

Risk of bias

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Harvey 2000 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...a computer generated random allocation schedule was determined before the study by an investigator who was not involved in patient recruitment or group allocation", p 1342
Allocation concealment (selection bias)	Low risk	Quote: "...allocations were placed in sealed, opaque, sequentially numbered envelopes by an investigator who was not involved in determining eligibility for the trial. The envelopes were not opened until after the initial tests had been performed", p 1342
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...a blinded therapist was responsible for all measurements", p 1344
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: No dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Harvey 2003

Methods	**Design:** Randomised within-subjects study
Participants	**Health condition:** Adults with spinal cord injury **Sample size:** Experimental group: 16 legs , Control group: 16 legs **Setting, Country:** 2 spinal injury rehabilitation units, Australia **Joint of interest:** Hip **Inclusion criteria:** • Sustained a spinal cord injury within the past 12 months • Commenced sitting out of bed following the initial injury • Less than 110° passive hip flexion with the knee extended **Exclusion criteria:**

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	• More than grade 2/5 motor strength in the muscles around the hips and knees • Unlikely to remain in the unit for 4 weeks • History of trauma to the pelvis or upper leg • Unable to tolerate stretch **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 33 years (15), Control group: 33 years (15) **Gender:** Not reported
Interventions	**Groups included in this review:** ***Experimental group: Stretch*** Participants received a stretch to the hamstring muscles with a 30 Nm torque using a purpose-built device. Participants also performed normal activities of daily living Total stretch time: 30 min x 5 d x 4 weeks = 10 h over a 4-week period ***Control group: Non-stretch*** Participants did not receive any stretches to the hamstring muscles Participants performed normal activities of daily living ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Hip flexion at 30 Nm torque (degrees) **Other outcomes:** Nil **Time points included in this review:** Outcomes measured at 4 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...a computer-generated random allocation schedule was produced prior to the study by one of the authors who was not otherwise involved in subject recruitment or allocation", p 178
Allocation concealment (selection bias)	Low risk	Quote: "...to ensure concealment, the same person placed allocations in sealed, opaque, sequentially-numbered envelopes. The envelopes were not opened until after the initial tests had been performed", p 178
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists

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Harvey 2003 (*Continued*)

Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...measurements were taken...by an independent therapist who was blinded to allocation", p179
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: No dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Harvey 2006

Methods	**Design:** Randomised within-subjects and parallel-group study
Participants	**Health condition:** Adults with spinal cord injury, stroke or traumatic brain injury **Sample size:** Total: Experimental group: 30 thumbs, Control group: 30 thumbs Spinal cord injury[1]: Experimental group: 19 thumbs, Control group: 20 thumbs Stroke[2]: Experimental group: 7 thumbs, Control group: 7 thumbs Traumatic brain injury[3]: Experimental group: 4 thumbs, Control group: 3 thumbs **Setting, Country:** Community participants, Australia **Joint of interest:** Thumb carpometacarpal **Inclusion criteria:** • Sustained a cervical spinal cord injury, traumatic brain injury or stroke that affected one or both upper limbs • Had a contracture of their thumb web-space as assessed by clinical examination **Exclusion criteria:** • Had a contracture deemed unlikely to respond to stretch **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (range):** *Unilateral participants:* Experimental group: 58 years (49-67), Control group: 64 years (50-71) *Bilateral participants:* Experimental group: 47 years (37-51), Control group: 47 years (37-51) **Gender:** Experimental group: 13% female, Control group: 30% female
Interventions	**Groups included in this review:** ***Experimental group: Thumb splint*** Participants' thumbs were stretched by splinting them into abduction. One of two splints was used: Splint 1: volar splint with a C-bar to position the thumb into palmar abduction Splint 2: cone splint used where it was difficult to obtain a good stretch with the thumb C-bar piece

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	Splints were reviewed at week 1, week 4 and week 8 after baseline Participants were also instructed to refrain from self-administering any other stretch Total stretch time: 8 h x 7 d x 12 weeks = 672 h over a 12-week period ***Control group: No splint*** Participants received no intervention. Participants were instructed to refrain from self-administering any stretch ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Palmar abduction of the thumb carpometacarpal joint (degrees) • The effect of the splinting regime on self selected goals (Canadian Outcome Performance Measure) **Other outcomes:** Questionnaire on participants' attitudes towards the effectiveness and convenience of the splinting regime **Time points included in this review:** Outcomes measured at 12 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	[1]Spinal cord injury subgroup of Harvey 2006 study; [2]Stroke subgroup of Harvey 2006 study; [3]Traumatic brain injury subgroup of Harvey 2006 study; data obtained via correspondence with study author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...an independent person used a computer to generate the random allocation schedules", p 252
Allocation concealment (selection bias)	Low risk	Quote: "...these were placed in opaque, sequentially numbered envelopes which were sealed and kept off site", p 252
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...the assessors were blinded to participant allocation and participants were asked not to discuss any aspect of the trial with the assessors in order to maintain blinding", p 252
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants

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Harvey 2006 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 1/60 (2%) dropouts
Selective reporting (reporting bias)	Unclear risk	Comment: Canadian Outcome Performance Measure was discontinued
Other bias	Low risk	Comment: Appears free of other bias

Hill 1994

Methods	**Design:** Randomised cross-over study
Participants	**Health condition:** Adults with brain injury **Sample size:** Experimental group: 8[1], Control group: 7[1] **Setting, Country:** Inpatient rehabilitation hospital, USA **Joint of interest:** Elbow and wrist **Inclusion criteria:** • ≥ 8 years old • Unilateral or bilateral hypertonicity • Contractures in upper extremities that interfered with function • ≤ 2 years since injury • Able to follow simple instructions and participate in self-care skills **Exclusion criteria:** • Previously treated with casts • Absent sensation in affected extremity **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (range):** Experimental group: 25 years (9-44), Control group: 32 years (19-48) **Gender:** Not reported
Interventions	**Groups included in this review:** ***Experimental group: Serial casting followed by therapy (Group 1)*** Participants wore rigid circular elbow or wrist casts. Casts were re-applied each 5-7 d, with 4-6 casts applied in total. Limbs were positioned 5°-10° off maximal ROM Total stretch time: 24 h x 7 d x 4.33 weeks = 728 h over a 4-week period ***Control group: Therapy followed by serial casting (Group 2)*** Participants received traditional treatments included passive and active movements, prolonged stretch, splinting, neurophysiological treatment techniques and relaxation techniques ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Unidirectional passive joint ROM (degrees) • Joint angle at which stretch reflex elicited (degrees) • Observation of performance of functional tasks **Other outcomes:** Observation of rapid alternating movements **Time points included in this review:** Outcomes measured at 1 month (cross-over point)

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Hill 1994 (*Continued*)

	Other time points: Outcomes also measured at baseline, 2 months (end of intervention)
Notes	[1]Number of participants who were analysed by the study authors (i.e. these numbers do not include dropouts). Study authors did not report the size of the group allocations at baseline

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "Subjects were alternately assigned", p 220
Allocation concealment (selection bias)	High risk	Quote: "Subjects were alternately assigned", p 220
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "The evaluations were performed by an experienced occupational therapist who was blind to the treatment each patient was receiving", p 220
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 5/20 (25%) dropouts
Selective reporting (reporting bias)	High risk	Comment: Insufficient detail reported to include in meta-analysis
Other bias	Low risk	Comment: Appears free of other bias

Horsley 2007

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke or stroke-like brain injury **Sample size:** Experimental group: 20, Control group: 20 **Setting, Country:** Inpatient rehabilitation hospital, Australia **Joint of interest:** Wrist **Inclusion criteria:** • Stroke or stroke-like brain injury (i.e. subarachnoid haemorrhage resulting in hemiplegia, not traumatic head injury or Parkinson's disease)

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	• 18 years of age or over • Unable to actively extend the affected wrist past neutral **Exclusion criteria:** • Language, comprehension or reading problems which prevented informed consent • Co-existing upper-limb conditions that directly affected movement • Not able to participate in upper-limb rehabilitation **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 61 (21), Control group: 62 (17) **Gender:** Experimental group: 70% female, Control group: 35% female
Interventions	**Groups included in this review:** ***Experimental group: Stretch plus usual care*** Participants received a weight-bearing stretch of the arm in sitting, with the shoulder positioned in external rotation, slight abduction and extension, elbow in extension, forearm in supination and wrist and fingers in maximum extension. If unable to do stretch using this method, stretch performed manually or with a stretch board. Participants also received usual upper limb care. No wrist or finger stretches were administered Total stretch time: 30 min x 5 d x 4 weeks = 10 h over a 4-week period ***Control group: Usual care*** Participants received usual upper limb care. No wrist or finger stretches were administered ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive wrist extension (degrees) • Pain at rest at the time of testing (VAS) • Upper limb activity (composite of 3 items of MAS) **Other outcomes:** Nil **Time points included in this review:** Outcomes measured at 4 weeks (end of intervention) and 9 weeks (5 weeks after last intervention) **Other time points:** Outcomes also measured at baseline and 5 weeks (1 week after last intervention)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...computer-generated randomisation table", p 240
Allocation concealment (selection bias)	Low risk	Quote: "...kept by a person who was remote from the study site and independent of recruitment, and group allocation was revealed by phone call", p 240

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Horsley 2007 (*Continued*)

Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...outcome measures were collected by therapists...who were blind to group allocation", p 240
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 2/40 (5%) dropouts at 5 weeks, 3/40 (8%) dropouts at 9 weeks
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Horton 2002

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults following total knee replacement **Sample size:** Experimental group: 27, Control group: 28 **Setting, Country:** Acute hospital, UK **Joint of interest:** Knee **Inclusion criteria:** • Osteoarthritis or rheumatoid arthritis • Undergoing primary total knee replacement **Exclusion criteria:** • Previous surgery, other than arthroscopy **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 66 years (14), Control group: 69 years (10) **Gender:** Experimental group: 59% female, Control group: 46% female
Interventions	**Groups included in this review:** ***Experimental group: Splint*** Participants received a semi-rigid knee extension splint for the first 48 hours after total knee replacement surgery. Participants also received usual care Total stretch time: 24 h x 2 d = 48 h over 2 d ***Control group: No splint*** Participants received no splint after total knee replacement surgery Participants received usual care. ***Other groups:*** Nil

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Outcomes	**Outcomes included in this review:** • Knee fixed-flexion deformity (degrees) **Other outcomes:** Knee extension lag, active knee flexion and length of hospital stay **Time points included in this review:** Outcomes measured at 2 d (end of intervention) and 3 months (~ 3 months after last intervention) **Other time points:** Outcomes also measured at baseline and 1 week (5 days after last intervention)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: *"...patients were randomly assigned to two groups", p 229* Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Quote: "...randomisation was achieved by the closed envelope technique at the time of wound closure, blinding the surgeon to the intended study group until this time", p 229 Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Quote: "...to ensure she would remain blinded to the splint allocation, a second person was trained to take the 48-h measurements when the splints were still in use", p230 Comment: Second assessor not blinded to splint allocation for outcomes measured at 2 d
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 2/55 (4%) dropouts at 3-month follow-up
Selective reporting (reporting bias)	High risk	Comment: No data reported for 3-month follow-up

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Horton 2002 (*Continued*)

Other bias	Unclear risk	Comment: More participants were recruited than original power calculations indicated were necessary. No reason given

Hussein 2015

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with shoulder adhesive capsulitis **Sample size**: Experimental group: 30, Control group: 30 **Setting, Country**: Outpatient facility, USA **Joint of interest**: Shoulder **Inclusion criteria**: • 18 years of age or older • globally limited glenohumoral translation • loss of passive ROM (50% compared to the non-affected side) • no radiographic findings on anteroposterior, axillary or scapular y-view shoulder radiographs **Exclusion criteria**: • Bilateral shoulder involvement • Previous shoulder surgeries • Any neuromuscular disorders • Diabetes mellitus • Corticosteroid injection in the previous 6 months • Prior trauma (dislocation, fracture, tendon rupture) • Any intrinsic glenohumeral pathology (e.g. osteoarthritis) • Complex regional pain syndrome • Contraindications to treatment (joint fusion, severe osteoporosis, any signs or symptoms of peripheral nerve compression) • Pulmonary disease (active or latent pulmonary tuberculosis, chronic obstructive pulmonary disease, interstitial lung disease or any pulmonary malignancy) **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture **Mean age (SD):** Experimental group: 52 years (not reported), Control group: 51 years (not reported) **Gender**: Not reported
Interventions	***Experimental group*** : ***Static progressive stretch device plus traditional therapy*** Particiapnts used a static progressive stretch device once daily for 30 min/session in week 1, twice daily for 30 min/session in weeks 2-3 and thrice daily for 30 min/session in week 4 (readjusting the position of the stretch to tolerance every 5 min). Participants also received traditional therapy (details below) Total stretch time: (30 min x 7 d x 1 week) + (60 min x 7 d x 2 weeks) + (90 min x 7 d x 1 week) = 28 h over a 1-month period ***Control group : Traditional therapy*** Participants received 3 physical therapy sessions per week for 4 weeks (hot pack followed by manual therapy) with a home exercise programme (pulley, wand and pendulum exercises performed 3 times daily with 10 repetitions each)

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Hussein 2015 (*Continued*)

	Other groups *:* Nil
Outcomes	**Outcomes included in this review:** • Active shoulder abduction (degrees) • Pain (VAS) • Disabilities of the Arm, Shoulder and Hand Outcome Measure (DASH) **Other outcomes**: Passive shoulder abduction, passive shoulder external rotation, active shoulder external rotation **Time points included in this review**: Outcomes measured at 4 weeks (end intervention) and 12 weeks **Other**
Notes	Nil

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "Subjects were randomly assigned by a computerized random number generator created by an independent biostatistician at an independent treatment center", p 140
Allocation concealment (selection bias)	Unclear risk	Quote: "Subjects were randomly assigned by a computerized random number generator created by an independent biostatistician at an independent treatment center", p 140 Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "All clinical outcome measures were assessed by an independent physical therapist who was blinded to subjects' group allocation", p 140
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 0/63 (0%) dropouts

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Hussein 2015 (*Continued*)

Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes stated were reported
Other bias	High risk	Comment: The 100% follow-up rates at 2 years and the extremely large treatment effects were together highly improbable and raised suspicions about the conduct of the trial. In addition, the stretch devices used in this study were extremely costly yet the authors stated that they received no funding. It is not clear whether the company provided the devices

Hyde 2000

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Children with Duchenne muscular dystrophy **Sample size:** Experimental group: 15, Control group: 12 **Setting; Country:** 3 institutions; Norway, Sweden and Denmark **Joint of interest:** Ankle **Inclusion criteria:** • Diagnosis of Duchenne muscular dystrophy • Not less than 4 years of age • Able to walk independently without the use of orthoses **Exclusion criteria:** • Taking medication that might influence muscle strength • Previous lower limb surgery **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 7 years (2), Control group: 6 years (2) **Gender:** Experimental group: 0% female, Control group: 0% female
Interventions	**Groups included in this review:** ***Experimental group: Night splint plus passive stretch*** Participants received below-knee splints to be worn during the night Participants also received passive stretches to the tendo-achilles, hip flexors, knee flexors and iliotibial band. These stretches were performed 10 times per day Total stretch time: not reported ***Control group: Passive stretch*** Participants received passive stretches to the tendo-achilles, hip flexors, knee flexors and iliotibial band. These stretches were performed 10 times per day ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Tendo-achilles contracture • Motor ability scale **Other outcomes:** Hip flexor contracture, time taken to run 10 m, Gowers manoeuvre

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Hyde 2000 (*Continued*)

	(time taken to move from supine to standing), voluntary muscle strength **Time points included in this review:** Outcomes measured at 32 months (assessment 12) **Other time points:** Outcomes also measured at baseline (assessment 1), 1 month, 4 months (randomisation), 7 months, 10 months, 13 months, 17 months, 20 months, 23 months, 26 months and 29 months (assessment 11)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...randomization numbers from standard statistical tables for random numbers", p 258
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...the evaluators...were blinded to the randomized treatment group allocation and to the previous assessment", p 258
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 16/27 (59%) dropouts over length of study
Selective reporting (reporting bias)	High risk	Comment: Insufficient detail reported to include in meta-analysis
Other bias	Low risk	Comment: Appears free of other bias

Jang 2015

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with recent (< 30 days) burns around the shoulder joint **Sample size**: Experimental group: 11, Control group: 13 **Setting, Country**: Inpatient rehabilitation centre in a general hospital, South Korea **Joint of interest**: Shoulder **Inclusion criteria**:

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	• burns around the shoulder joint • the total burn surface area (TBSA) was > 10% and < 80% • date of burning was < 30 days before the patient was included in the study **Exclusion criteria**: • septic condition that could limit their participation • were planning to undergo skin graft surgery around the shoulder • had a severe cognitive deficit that could prevent them from following instructions • neurological impairment of the upper extremity that related to the shoulder burn **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 43.5 years (10.4), Control group: 48.3 years (6.9) **Gender**: Experimental group: 18% female, Control group: 23% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Shoulder splint and usual care*** Participants wore a multi-axis shoulder abduction splint to keep the shoulder abducted at 90° abduction after shoulder burn. Participants also received usual care (details below) Total stretch time: 24 h x 7 d x 4 weeks = 672 h over a 1-month period ***Control group: Usual care*** Participants were prescribed an exercise programme which consisted of sessions of passive and active mobilisation and stretching for 30 min twice a day ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Active shoulder abduction (degrees) **Other outcomes**: Active shoulder flexion, active shoulder external rotation T**ime points included in this review**: Outcomes were measured at 4 weeks (end of intervention) **Other time points:** Outcomes also measured at baselines, week 1, week 2 and week 3
Notes	Participants exercised for 30 min twice daily, so the total splint wear time was 23 h/day

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "...randomization procedure involving a computer-generated random number sequence…", p 440
Allocation concealment (selection bias)	Low risk	Quote: "...sealed envelopes with random numbers were used to allocate the patients", p 440
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists

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Jang 2015 (*Continued*)

Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...by assessors who were blinded to whether the patient was being splinted", p 441
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: Figure 1: 24/26 (8%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Unclear risk	Comment: Insufficient detail provided

Jerosch-Herold 2011

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults following surgical release for Dupuytren's contracture **Sample size**: Experimental group: 77, Control group: 77 **Setting, Country**: 5 National Health Service Hospital Trusts, UK **Joint of interest**: Hand **Inclusion criteria**: • Dupuytren's contracture affecting one or more fingers of either hand • Requiring surgical release by fasciectomy or dermofasciectomy • Over 18 years of age **Exclusion criteria**: • Contracture affecting the thumb or first web space only **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture **Mean age (SD):** Experimental group: 67 years (10), Control group: 68 years (9) **Gender**: Experimental group: 21% female, Control group: 23% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Static night splint plus hand therapy*** Particicpants wore a custom-made thermoplastic splint which accommodated the operated rays of the hand with the metacarpophalangeal joints and/or proximal interphalangeal joints held in maximum extension without causing any tension to the wound. The splint was remoulded intermittently to achieve a greater extension force. Participants were instructed to wear the splint at night only. Participants also received hand therapy (details below) Total stretch time: 8 h x 182 d (6 months) = 1456 h over a 6-month period **Control group**: ***Hand therapy*** Participants received hand therapy aimed at reducing oedema, promoting wound healing, maximising finger range of movement and facilitating full return to functional use of the hand, including oedema control, exercises and advice. If a participant had a net loss of

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	15 degrees or more at the proximal interphalangeal joint and/or a net loss of 20 degrees or more at the metacarpal phalangeal joint of the operated fingers, they were then given a splint ***Other groups*** : Nil
Outcomes	**Outcomes included in this review:** • Active extension of the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joint of the operated fingers (degrees) • Disabilities of Arm Shoulder and Hand Questionnaire (DASH; 1-100 points) **Other outcomes** Active flexion of the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints of the operated fingers, patient satisfaction with the outcome, recurrence at 1 year **Time points included in this review**: Outcomes measured at 6 months (end intervention) and 12 months after surgery **Other time points:** Outcomes also measured prior to surgery, and at 3 months after surgery Patient satisfaction was assessed only at 6 and 12 months
Notes	Assumed participants wore the splint for 8 h per night when calculating total stretch time

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Randomisation was stratified by centre (five centres) and by surgical procedure (fasciectomy or dermofasciectomy) in block lengths of 4. The allocation sequence was generated and administered independently through a central telephone randomisation service", p 4 Comment: Not clear how the randomisation sequence was generated
Allocation concealment (selection bias)	Low risk	Quote: "The allocation sequence was generated and administered independently through a central telephone randomisation service", p 4
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	High risk	Quote: "The primary outcome measure was patient-reported and participants could not be blinded. Secondary outcomes were collected by the research associates who were also not blinded, although they

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Jerosch-Herold 2011 (*Continued*)

		were independent of the clinical staff delivering the interventions", p 5
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 6/154 (3%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes stated were reported. Abandoned the recurrence at 1-year outcome
Other bias	High risk	Quote: "13 patients allocated to the no-splint group (17%) went on to develop a contracture of the PIPJ which exceeded the agreed threshold and were subsequently given a splint as per protocol", p 4 Comment: Crossover from control to experimental group, but analysis was by intention-to-treat

John 2011

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with hallux limitus in the first metatarsophalangeal joint following surgery **Sample size**: Experimental group: 25, Control group: 25 **Setting, Country**: Outpatient clinics, USA **Joint of interest**: Metatarsophalangeal joint of great toe **Inclusion criteria**: • Reduced flexibility in active ROM of extension in the great toe • Pain that is worsened by walking and/or squatting • Impaired gait pattern **Exclusion criteria**: • Metatarsal stress fracture • Interdigital neuroma • Sesamoid pathology • Gout • Metatarsalgia **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture **Mean age (SD):** Not reported (Range: 29-69 years) **Gender**: Experimental group: 44% female, Control group: 60% female

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John 2011 (*Continued*)

Interventions	**Groups included in this review:** ***Experimental group* :*Dynamic splint and usual care*** Participant wore a dynamic splint for first metatarsophalangeal joint of the great toe. They also received usual care (details below) Total stretch time: 3 h x 7 d x 8 weeks = 168 h over a 2-month period ***Control group* : *Usual care*** Participants were prescribed nonsteroidal anti-inflammatory drugs and orthotics. They were also given instructions for home exercises ***Other groups* :** Nil
Outcomes	**Outcomes included in this review:** • Active dorsiflexion at the first metatarsal joint of the hallux (great toe) (degrees) **Other outcomes**: Nil **Time points included in this review**: Outcomes measured at 8 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	Nil

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Comment: Insufficient detail reported
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "Two control patients withdrew from the study because of excessive pain that required additional treatment", p 287
Selective reporting (reporting bias)	Unclear risk	Comment: Does not clearly state outcomes and only reports on one outcome

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John 2011 (*Continued*)

Other bias	High risk	Comment: Inadequate reporting to gauge other possible sources of bias

Jongs 2012

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with contracture following distal radial fracture **Sample size**: Experimental group: 19, Control group: 21 **Setting, Country**: Outpatient clinics, Australia **Joint of interest**: Wrist **Inclusion criteria**: • Diagnosis of stable and united (or uniting) unilateral fracture • Wrist contracture evident by a loss of passive extension compared to the unaffected wrist • Living in the Sydney metropolitan region • Aged over 18 years **Exclusion criteria**: • Unlikely to co-operate **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture **Mean age (IQR):** Experimental group: 66 years (56-72), Control group: 58 years (52-65) **Gender**: Experimental group: 79% female, Control group: 62% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Splint and routine care*** Participants wore a dynamic splint during the day which stretched the wrist into extension but allowed intermittent movement. They also received routine care (details below) Total stretch time: 6 h x 7 d x 8 weeks = 336 h over a 2-month period ***Control group : Routine care*** Participants received exercises and advice for 8 weeks ***Other groups*** : Nil
Outcomes	**Outcomes included in this review:** • Passive wrist extension (degrees) • Pain and function (Patient Rated Hand Wrist Evaluation/100) • Canadian Occupational Performance Measure for Performance (points) **Other outcomes**: Active wrist extension, active wrist flexion, active radial deviation, active ulnar deviation, Canadian Occupational Performance Measure for Satisfaction **Time points included in this review**: Outcomes measured at 8 weeks (end of intervention) and 12 weeks **Other time points:** Outcomes also measured at baseline
Notes	Nil

Risk of bias

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Jongs 2012 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "..a computerised blocked randomisation sequence was generated prior to the commencement of the trial by an independent offsite person", p 174
Allocation concealment (selection bias)	Low risk	Quote: "Participants' allocations were placed in opaque sealed and sequentially numbered envelopes that were held offsite", p 174
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "A blinded assessor performed assessments at 8 weeks, ...an assessor not blinded to group allocation performed assessments at 12 weeks", p 174 Comment: Only data from the 8-week assessments were used in the meta-analyses
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 4/40 (10%) dropouts at 8 weeks and 8/40 (20%) dropouts at 12 weeks
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Kemler 2012

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with Dupuytren's disease **Sample size**: Experimental group: 28, Control group: 26 **Setting, Country**: Outpatient clinics, Netherlands **Joint of interest**: Proximal interphalangeal **Inclusion criteria**: • Dupuytren's disease with a proximal interphalangeal joint flexion contracture of at least 30° • Underwent surgical release of a Dupuytren's contracture

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	Exclusion criteria: • Below 18 years of age • Undergone partial amputation or arthrodesis of a digit • Insufficient knowledge of the Dutch language **Existing contracture, at risk of contracture, or combination of both**: Participants were at risk of developing contracture **Mean age (SD):** Experimental group: 63 years (9), Control group: 64 years (11) **Gender**: Experimental group: 18% female (n = 5), Control group: 12% female (n = 3)
Interventions	**Groups included in this review:** ***Experimental group*** : ***Hand splint and usual therapy*** Participants wore a dorsal static extension splint postoperative. They also received usual therapy (details below) Total stretch time: (24 h x 28 d) + (8 h x 7 weeks x 7 d) = 672 h + 392 h = 1,064 h over a 3-month period[1] ***Control group : Usual therapy*** Participants received a standardised programme of graded exercises designed to improve the strength, mobility and function of the affected hand (30 min twice weekly; total duration 3 months, starting 10 d after surgery) ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive extension of proximal interphalangeal joint (degrees) • Pain (VAS) **Other outcomes**: Global perceived effect, comfort of wearing splint **Time points included in this review**: Outcomes measured at 6 weeks and 1 year **Other time points:** Outcomes also measured at 3 months (but only at 1 site)
Notes	[1]Total stretch time calculations based on: participants were instructed to apply the splint day and night during the first 4 weeks, but removed for exercises at least 5 times/d for 15 min. Then: participants gradually began to use their hands normally in the daytime and the night splintage was continued

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Table of random numbers was used to make the treatment assignments", p 734
Allocation concealment (selection bias)	Unclear risk	Quote: "The assignments were made by a research assistant", p 734 Comment: Not clear if the research assistant had access to the allocation schedule or was involved in making decisions about inclusion

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Kemler 2012 (*Continued*)

Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "..concealed from the outcome assessor", p 734
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "After 1 year, all patients were available for follow-up", p 735
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Unclear risk	Comment: The 6-week and 3-month data were only collected at one site (n = 36)

Kolmus 2012

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with an axillary burn (anterior chest involving the axillary fold, anterior, lateral or posterior shoulder and the axillary region) **Sample size**: Experimental group: 27, Control group: 25 **Setting, Country**: Burns unit of an acute hospital, Australia **Joint of interest**: Shoulder **Inclusion criteria**: • Aged 18 years and over • Axillary burn **Exclusion criteria**: • Not requiring surgical management • Pre-existing shoulder pathology impacting on range and function • Sustained an additional injury to the burned shoulder (fracture, muscle or ligament tear) • Greater than 50% total body surface area burn injury • Admitted for chronic burn contracture release **Existing contracture, at risk of contracture, or combination of both**: Participants were at risk of developing contracture **Mean age (SD):** Experimental group: 49 years (19), Control group: 44 years (18) **Gender**: Experimental group: 30% female, Control group: 40% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Shoulder splint and usual care*** Participants wore an Otto Bock Omo Immobil shoulder splint, holding the shoulder in

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	90° abduction for 12 weeks. They also received usual care (details below) Total stretch time: (24 h x 7 d x 6 weeks) + (8 h x 7 d x 6 weeks) = 1344 h over a 3-month period[1] ***Control group : Usual care*** Participants received a daily exercise programme which included stretching, strengthening and functional retraining of the affected upper limb ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Shoulder range of abduction (degrees,) • Burn Specific Health Scale-Brief (points) • Upper Extremity Functional Index scale (points) **Other outcomes**: Shoulder range of flexion, the Grocery Shelving Task, length of stay **Time points included in this review**: Outcomes measured at 12 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline and 6 weeks
Notes	[1] "… adherence with splint use was generally poor…" p 640 (no detailed adherence data provided)

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "Randomisation was completed via a computer generated program", p 639
Allocation concealment (selection bias)	Low risk	Quote: "...allocation was concealed using opaque envelopes", p 639
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "Outcomes measured by an independent data collector who was blinded to group allocation", p 639
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: Figure 1, Week 12: 40/52 = 77%
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported

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Other bias	Unclear risk	Comment: Table 2 contains data on length of stay that were not described as an outcome in the text

Krumlinde-Sundholm 2011

Methods	**Design**: Randomised cross-over study
Participants	**Health condition**: Children with cerebral palsy (12 children had unilateral and 14 bilateral cerebral palsy) **Sample size**: 37 children (cross-over) **Setting, Country**: Hand clinic, Sweden **Joint of interest**: Wrist and thumb **Inclusion criteria**: • Children with cerebral palsy already using splints **Exclusion criteria**: Nil reported **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Both groups: 10 years (range 1-16) **Gender**: Not reported
Interventions	**Groups included in this review:** ***Experimental group*** : ***Hand splint and usual care*** Participants received a hand splint for 6 months. Total stretch time: 8 h x 7 d x 26 weeks = 1456 h[1] ***Control group*** : ***Usual care*** Participants did not receive a hand splint ***Other groups*** : Nil
Outcomes	**Outcomes included in this review:** • Passive wrist extension (degrees) **Other outcomes**: Passive thumb abduction **Time points included in this review**: Outcomes measured at 6 months (end of intervention) **Other time points:** Outcomes also measured at 3 months, 9 months and 12 months
Notes	[1]This assumes participants wore the splint each night for 8 h

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported.

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Krumlinde-Sundholm 2011 (*Continued*)

Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...blinded to group allocation", p 26
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Quote: "During the 12 month trial period 11 [of 37] dropped out leaving 26 children", p 27 Comment: 11/47 (30%) dropout
Selective reporting (reporting bias)	Unclear risk	Comment: Insufficient detail reported
Other bias	Unclear risk	Comment: Only an abstract so difficult to assess susceptibility to bias

Lai 2009

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 15[1], Control group: 15[1] **Setting, Country:** Not reported, USA **Joint of interest:** Elbow **Inclusion criteria:** • 18-75 years old • Sustained stroke at least 6 months before entering study • Modified Ashworth scale score of 2 or more during elbow extension • ROM deficit of greater than 24% in elbow extension **Exclusion criteria:** • History of fracture to affected limb 3 months prior to enrolment • Taking aminoglycosides • Had botulinum toxin injections within the previous 4 months prior to enrolment • Fixed, mechanical impingement blocking active ROM • Previous phenol injections to the study limb • Received serial casting of the study limb in the past 4 months • Histories of other central neurological pathologies • Had baclofen pump implants • Pregnant, nursing, or may become pregnant • Unable to attend the scheduled twice-weekly therapy appointments **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 49 years (4), Control group: 56 years (5)

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	Gender: Experimental group: 53% female, Control group: 33% female
Interventions	**Groups included in this review:** ***Experimental group: Extension splint plus botulinum toxin and therapy*** Participants wore an elbow extension dynasplint in addition to botulinum toxin and therapy. Tension was increased 1 increment every 2 weeks, based on participant's tolerance. The initial tension setting was #2 (16 kg/cm of torque), and the mean final tension setting was #6 (58 kg/cm of torque). Participants also received botulinum toxin and therapy (details below) Total stretch time: (6-8 h) x 7 d x 14 weeks = 588 h to 784 h over a 14-week period ***Control group: Botulinum toxin and therapy*** All participants received botulinum toxin injections and occupational and manual therapies. The botulinum toxin injections were injected into the biceps brachialis, and brachioradialis muscles, and the occupational and manual therapies occurred weekly for 16 weeks. The occupational and manual therapy protocols included moist heat, education, joint mobilisation, passive ROM, active ROM, proprio-neural facilitation and therapeutic exercise ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Maximal active ROM (elbow extension) • Modified Ashworth scale (extension score) **Other outcomes:** Nil **Time points included in this review:** Outcomes measured at 14 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline, 1 week
Notes	[1]Number of participants analysed by the study authors (i.e. these numbers do not include dropouts). Authors did not report the size of the group allocations at baseline

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...selected with a randomized list", p 244 Comment: No information on allocation concealment reported.
Allocation concealment (selection bias)	Unclear risk	Quote: "...selected with a randomized list", p 244 Comment: No information on allocation concealment reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists

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Lai 2009 (*Continued*)

Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Quote: "Upon enrolment, all patients ... measured by the same therapist before and after the BTX injections", p 243 Comment: Information about assessor blinding was not stated
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 6/36 (17%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Unclear risk	Quote: "This study was funded by Dynasplint Systems Inc.", p 246 Comment: Unclear threat to bias

Lannin 2003a

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke or brain injury **Sample size:** Experimental group: 17, Control group: 11 **Setting, Country:** Inpatient rehabilitation unit, Australia **Joint of interest:** Wrist (long finger flexors) **Inclusion criteria:** • Single stroke or brain injury no more than 6 months prior • Upper-limb hemiplegia • Unable to actively extend the affected wrist • 18-80 years old **Exclusion criteria:** • Language comprehension, perceptual, or cognitive deficits that would prevent written, informed consent or participation in the programme **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 65 years (16), Control group: 68 years (7) **Gender:** Experimental group: 53% female, Control group: 55% female
Interventions	**Groups included in this review:** ***Experimental group: Splint plus routine therapy*** Participants wore a static, palmar resting mitt splint on a daily basis for a maximum of 12 h each night. Participants also received routine therapy (details below) Total stretch time: 12 h x 7 d x 4 weeks = 336 h over a 4-week period ***Control group: Routine therapy*** Participants received routine therapy for individual motor training and upper-limb

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	stretches 5 d/week. Upper limb stretches involved a seated weight-bearing stretch and a seated upper limb stretch using an inflatable long-arm air splint ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive wrist extension (degrees) • Upper limb pain (VAS) • Upper limb activity (composite of 3 items of MAS) **Other outcomes:** MAS - item 6, MAS - item 7, MAS - item 8 **Time points included in this review:** Outcomes measured at 4 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline and 5 weeks (1 week after end of intervention)
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "...a random number table was used to generate the random number sequence", p 298
Allocation concealment (selection bias)	Low risk	Quote: "...the investigator contacted an independent person to obtain group allocation for each subject. This ensured concealed randomization", p 298
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...both assessors were blinded to allocation", p 298
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 3/28 (10%) dropouts for 4-week outcomes, 1/28 (4%) dropouts for 5-week outcomes
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported

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Lannin 2003a (*Continued*)

Other bias	Low risk	Comment: Appears free of other bias

Lannin 2007a

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 21, Control group: 21, Other group: 21 **Setting, Country:** 9 inpatient rehabilitation units, Australia **Joint of interest:** Wrist (long finger flexors) **Inclusion criteria:** • Stroke within previous 8 weeks • Aged 18 years or older • No active wrist extension • Sufficient cognitive and hearing function to be able to provide informed consent and fully participate in the trial • Resided in the greater Sydney metropolitan area **Exclusion criteria:** Nil reported **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 69 years (12), Control group: 75 years (11), Other group: 70 years (13) **Gender:** Experimental group: 43% female, Control group: 57% female, Other group: 52% female
Interventions	**Groups included in this review:** ***Experimental group: Wrist extension splint and usual rehabilitation*** Participants wore a custom-made, static, palmar mitt splint for up to 12 h overnight. The wrist was positioned in a comfortable end-of-range extended position with the metacarpophalangeal and interphalangeal joints extended. Participants also received usual rehabilitation, except that stretches of the wrist or long finger flexor muscles were not performed during the study period. A maximum of 10 min of isolated wrist and finger extension practice was permitted per day Total stretch time: 12 h x 7 d x 4 weeks = 336 h over a 4-week period ***Control group: No splint and usual rehabilitation*** Participants did not wear a hand splint for the study period Participants received usual rehabilitation, except that stretches of the wrist or long finger flexor muscles were not performed during the study period. A maximum of 10 min of isolated wrist and finger extension practice was permitted per day ***Other group: Neutral wrist splint*** Participants wore a custom-made, static, palmar mitt splint for up to 12 h overnight. The wrist was positioned in 0-10° extension Participants also received usual rehabilitation, except that stretches of the wrist or long finger flexor muscles were not performed during the study period. A maximum of 10 min of isolated wrist and finger extension practice was permitted per day Total stretch time: 12 h x 7 d x 4 weeks = 336 h over a 4-week period

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Outcomes	**Outcomes included in this review:** • Passive wrist extension (degrees) • Pain (Disabilities of the Arm, Shoulder, and Hand Outcome Measure - pain severity item) • Spasticity angle (Tardieu scale) • Disabilities of the Arm, Shoulder, and Hand Outcome Measure (DASH) **Other outcomes:** Upper limb activity (composite of 3 items of MAS), Spasticity rating (Tardieu) **Time points included in this review:** Outcomes measured at 4 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline and 6 weeks (2 weeks after end of intervention)
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "...the allocation schedule was computer generated", p 112
Allocation concealment (selection bias)	Low risk	Quote: "...concealed in opaque, consecutively numbered envelopes by a person not otherwise involved in the study", p 112
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...measures were assessed...by an independent assessor who was unaware of which treatment the patient had received", p 112
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 1/63 (2%) dropouts at 4-week assessment, 4/63 (6%) dropouts for primary outcome at 6-week assessment
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

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Law 1991

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Children with spastic cerebral palsy **Sample size:** Experimental group: 19[1], Control group: 18[1], Other group A: 17[1], Other group B: 18[1], Entire sample: 79[2] **Setting, Country:** 3 treatment centres for disabled children, Canada **Joint of interest:** Wrist (wrist flexors) **Inclusion criteria:** • Spastic cerebral palsy (hemiplegia or quadriplegia) • Spasticity of wrist and hand • Parent able to attend therapy • Age 18 months to 8 years **Exclusion criteria:** • Skin sensitivity to casting material • Fixed, permanent wrist contracture • Upper-extremity surgery planned during intervention period • Severe developmental disability **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Not reported **Gender:** Experimental group: 68% female, Control group: 56% female, Other group A: 59% female, Other group B: 61% female
Interventions	**Groups included in this review:** ***Experimental group: Cast plus intensive neurodevelopmental therapy (NDT)*** Participants wore an upper extremity inhibitory short arm cast for a minimum of 4 h per day. The cast immobilised the wrist in neutral to 10° extension. Participants also received 45 min of NDT therapy twice weekly plus a home programme for 30 min/d Total stretch time: 4 h x 7 d x 26 weeks = 728 h over a 26-week period ***Control group: Intensive neurodevelopmental therapy (NDT)*** Participants received 45 min of NDT therapy twice weekly plus a home programme for 30 min/d ***Other group A: Regular neurodevelopmental therapy (NDT) plus cast*** Participants wore an upper extremity inhibitory short arm cast for a minimum of 4 h/d. The cast immobilised the wrist in neutral to 10 degrees extension Participants also received NDT therapy for a minimum of once per month up to a maximum of once per week. Participants performed a home programme for 15 min, 3 times per week Total stretch time: 4 h x 7 days x 26 weeks = 728 h over a 26-week period ***Other group B: Regular neurodevelopmental therapy (NDT)*** Participants received NDT therapy for a minimum of once per month up to a maximum of once per week. Participants performed a home programme for 15 min, 3 times per week
Outcomes	**Outcomes included in this review:** • Wrist ROM (scale not reported) • Peabody fine motor scale **Other outcomes:** Quality of Upper Extremity Skills Test (QUEST) **Time points included in this review:** Outcomes measured at 6 months (end of intervention) and 9 months (3 months after end of intervention)

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Law 1991 (*Continued*)

	Other time points: Outcomes also measured at baseline
Notes	[1]Number of participants who were *analysed* by the study authors (i.e. these numbers do not include dropouts). Authors did not report the size of the group allocations at baseline [2] Number of participants who were randomised.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...outcomes were assessed by an evaluator, blind to the children's status at commencement", p 381
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 7/79 (9%) dropouts
Selective reporting (reporting bias)	High risk	Comment: Insufficient detail reported to include in meta-analysis
Other bias	High risk	Quote: "...one nine month assessment was omitted because of consistently missed appointments", p 382 Comment: Not analysed by intention-to-treat

Lee 2007

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adult women following radiotherapy for breast cancer **Sample size:** Experimental group: 31, Control group: 30 **Setting, Country:** Outpatients department, Australia **Joint of interest:** Shoulder **Inclusion criteria:**

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	• Undergone breast cancer surgery • Receiving radiotherapy to the breast, chest wall or supra-clavicular area **Exclusion criteria:** • Radiotherapy to the axilla **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 55 years (13), Control group: 53 years (12) **Gender:** Experimental group: 100% female, Control group: 100% female
Interventions	**Groups included in this review:** ***Experimental group: Stretch plus usual care*** Participants received an individualised pectoral muscle stretching programme consisting of low-load, prolonged, passive stretches of pectoralis major and minor while in supine-lying Participants also followed an independent exercise programme outlined in a pamphlet given to them after breast cancer surgery, which consisted of gentle shoulder ROM exercises. Participants were seen by the physiotherapist on a weekly basis during their radiotherapy for skin care, lymphoedema information and reviewing the above stretches Total stretch time: 10 min x 2 muscles x 2 sessions x 7 d x 30.33 weeks = 141.5 h over a 30-week period ***Control group: Usual care*** Participants followed an independent exercise programme outlined in a pamphlet given to them after breast cancer surgery. The exercise programme consisted of gentle shoulder ROM exercises. Participants were also seen by the physiotherapist on a weekly basis during their radiotherapy for skin care and lymphoedema information only ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive shoulder horizontal extension of the affected arm • Pain after arm ROM measurement (VAS) • European Organization for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire (QLQ-C30) **Other outcomes:** Passive shoulder horizontal extension ROM - unaffected, passive shoulder forward flexion ROM - affected, passive shoulder forward flexion ROM - unaffected, passive shoulder external rotation ROM - affected, passive shoulder external rotation ROM - unaffected, active shoulder abduction ROM - affected, active shoulder abduction ROM - unaffected, pain after arm ROM measurement - unaffected, European Organization for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire (QLQ-C30), shoulder horizontal flexion strength - affected, shoulder horizontal flexion strength - unaffected, shoulder forward flexion strength - affected, shoulder forward flexion strength - unaffected, shoulder horizontal extension - affected, shoulder horizontal extension strength - unaffected, shoulder abduction strength - affected, shoulder abduction strength - unaffected, Shoulder external rotation strength - affected, shoulder external rotation strength - unaffected, arm swelling **Time points included in this review:** Outcomes measured at 7 months (end of intervention). **Other time points:** Outcomes also measured at baseline and 6 weeks (end of radiotherapy)

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Notes	Pain and quality of life data were not reported in the publications and were therefore obtained directly from the authors

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...participants were randomised to either a control or stretch group using computer-generated randomisation schedule", p 314
Allocation concealment (selection bias)	Low risk	Quote: "...allocation was concealed by the use of numbered opaque envelopes", p 314 Comment: Insufficient detail reported in paper whether envelopes were sealed. Correspondence with study author revealed that envelopes were sealed prior to randomisation
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...participants were measured by a physiotherapist blinded to group allocation at each of the three measurements.."
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 5/61 (8%) dropouts (Note: Review authors treated self-reported outcomes as dropouts)
Selective reporting (reporting bias)	High risk	Comment: No results reported for pain and quality of life
Other bias	High risk	Comment: Changed protocol midway through trial

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McNee 2007

Methods	**Design:** Randomised cross-over study
Participants	**Health condition:** Children with cerebral palsy **Sample size:** Experimental group: 5, Control group: 4 **Setting, Country:** Outpatient clinic, UK **Joint of interest:** Ankle **Inclusion criteria:** • Over the age of 5 years • Mild fixed ankle plantarflexion contractures • Clinical recommendation of serial casting to improve ankle dorsiflexion range **Exclusion criteria:** • Botulinum toxin injections in the past 6 months • Previous surgery to the calf musculature **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 7 years (not reported), Control group: 7 years (not reported) **Gender:** Experimental group: 40% female, Control group: 75% female
Interventions	**Groups included in this review:** ***Experimental group: Cast*** [1] Participants had a short leg cast applied in prone with the knee flexed. Casts were re-applied each week. Casts were not re-applied if there had been no improvement in ROM or if a target ROM (10° dorsiflexion) had been achieved Total stretch time: 24 h x 7 d x (3-4 weeks) = 504-672 h over a 3-4-week period ***Control group: No cast*** [1] Participants did not receive a cast ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive ankle dorsiflexion with the knee extended (degrees) • Normalcy index (NI) for walking **Other outcomes:** Maximum passive ankle dorsiflexion with the knee flexed, maximum ankle dorsiflexion in single-support, maximum ankle dorsiflexion in swing, minimum knee flexion in stance, minimum hip flexion in stance, Gillette functional assessment questionnaire, walking speed, cadence, stride length, time in single-support **Time points included in this review:** Outcomes measured at 12 weeks (8-9 weeks after end of intervention) **Other time points:** Outcomes also measured at baseline and 5 weeks.
Notes	[1]Only includes details of the first period of the cross-over.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...participants in the study were allocated to one of two groups", p 465 Comment: Insufficient detail reported

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McNee 2007 (*Continued*)

Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Comment: Insufficient detail reported
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Comment: Insufficient detail reported
Selective reporting (reporting bias)	Unclear risk	Comment: Not clear how many kinematic variables were measured
Other bias	High risk	Comment: Some participants had treatments applied bilaterally. Not clear how bilateral data were dealt with

Melegati 2003

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with primary anterior cruciate ligament reconstruction **Sample size:** Experimental group: 18, Control group: 18 **Setting, Country:** Not reported, Italy **Joint of interest:** Knee **Inclusion criteria:** • Complete and isolated ACL rupture • Absence of previous surgical procedure in either knee • More than 2 months since ACL rupture • Over 15 years of age **Exclusion criteria:** Nil reported **Existing contracture, at risk of contracture, or combination of both:** Participants were at risk of developing contracture **Mean age (SD):** Experimental group: 28 years (3), Control group: 30 years (7) **Gender:** Experimental group: 0% female, Control group: 0% female
Interventions	**Groups included in this review:** ***Experimental group: Knee extension brace*** Participants wore a rehabilitation brace, locked in full extension, applied during the first postoperative week. The brace was only unlocked during ROM exercises. Full extension was maintained during gait and rest, including night-time

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	Total stretch time: 23 h x 7 d = 161 h over a 1-week period ***Control group: ROM brace (0 °-90 °)*** Participants wore a rehabilitation brace locked from 0°-90°, applied from the day of surgery to the seventh postoperative day. In both groups, the brace was unlocked in the ROM 0°-120° during the second post-operative week, and finally removed at the beginning of the third postoperative week. The rehabilitation programme was started on the day after surgery. All the subjects followed the same rigorous accelerated rehabilitation protocol ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive Knee extension (heel height difference; cm) **Other outcomes:** KT1000 measurement of ACL laxity **Time points included in this review:** Outcomes measured at 8 weeks post surgery (7 weeks after end of intervention) **Other time points:** Outcomes also measured at baseline, 2 weeks, 4 weeks, 4 months post surgery (KT1000 measurement only at this time point)
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Quote: "...who were alternately distributed into the groups after the operation", p 323
Allocation concealment (selection bias)	Unclear risk	Comment: No information on allocation concealment reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...the physician didn't know to which group the patients belonged", p 324
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: No dropouts reported
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported

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Melegati 2003 (*Continued*)

Other bias	Low risk	Comment: Appears free of other bias

Moseley 1997

Methods	**Design:** Randomised cross-over study
Participants	**Health condition:** Adults with traumatic brain injury **Sample size:** Experimental group: 5, Control group: 5 **Setting, Country:** Inpatient rehabilitation unit, Australia **Joint of interest:** Ankle (plantarflexors) **Inclusion criteria:** • Restricted passive ankle dorsiflexion that prevented the heels from touching the ground when standing with the hips extended • No contra-indications to casting • Ability to lie prone for plaster application **Exclusion criteria:** Nil reported **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: not reported, Control group: not reported, both groups: 29 years (11) **Gender:** Experimental group: not reported, Control group: not reported, both groups: 11% female
Interventions	**Groups included in this review:** ***Experimental group: Cast*** [1] Participants had a short leg cast applied in prone with the knee flexed. Gastrocnemius was stretched by placing knee in extension for prolonged periods of time. Participants also received motor training aimed at improving the performance of everyday tasks Total stretch time: 24 h x 7 d = 168 h over a 1-week period ***Control group: No cast*** [1] Participants did not receive a cast and did not stretch. Participants received motor training aimed at improving the performance of everyday tasks ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive ankle dorsiflexion (degrees) **Other outcomes:** Nil **Time points included in this review:** Outcomes measured at 7 d (end of intervention) . **Other time points:** Outcomes also measured at baseline
Notes	[1]Only includes details of the first period of the cross-over

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

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Moseley 1997 (*Continued*)

Random sequence generation (selection bias)	Unclear risk	Quote: "...the experimental and control conditions occurred in random order", p 243 Comment: Insufficient detail reported
Allocation concealment (selection bias)	Unclear risk	Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	High risk	Quote: "...one potential threat to the validity of the study was the use of a non-blinded measurer", p 246
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 1/10 (10%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Moseley 2005

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with ankle fracture **Sample size:** Experimental group: 51, Control group: 50, Other group: 49 **Setting, Country:** Outpatient clinics, Australia **Joint of interest:** Ankle **Inclusion criteria:** • Ankle fracture treated with cast immobilisation (with or without surgical fixation) • Cast removed in preceding 5 days • Approval received from orthopaedic specialist to weight-bear as tolerated or partial weight-bear • Reduced passive dorsiflexion (at least 5° less than the contralateral ankle) • Completed skeletal growth • No concurrent pathologies that affect the ability to perform everyday tasks or the measurement procedures **Exclusion criteria:** Not reported **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 47 years (15), Control group: 49 years (15), Other

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	group: 43 yeas (15) **Gender:** Experimental group: 53% female, Control group: 52% female, Other group: 53% female
Interventions	**Groups included in this review:** ***Experimental group: Long-duration stretch plus exercise*** Participants performed long-duration stretches by standing with the affected foot on a wedge with the back against a wall or, if weight bearing was not tolerated, in a sitting position. The slope of the wedge and the amount of weight borne through the leg were adjusted so that the participant felt a comfortable stretch in the ankle or calf muscles. Both the slope and the weight were progressed throughout the course of treatment. Participants also received ankle mobility and strengthening exercises, stepping exercises, and exercises involving weight bearing and balancing on the affected leg. Participants completed 30 repetitions of each exercise every day. Participants received gait training and advice Total stretch time: 30 min x 7 d x 4 weeks = 14 h over a 4-week period ***Control group: Exercise*** Participants received ankle mobility and strengthening exercises, stepping exercises, and exercises involving weight bearing and balancing on the affected leg. Participants completed 30 repetitions of each exercise every day. Participants received gait training and advice ***Other group: Short-duration stretch plus exercise*** Short duration stretches could be applied in a non-weight bearing position initially, with progression to standing as tolerated Participants also received ankle mobility and strengthening exercises, stepping exercises, and exercises involving weight bearing and balancing on the affected leg. Participants completed 30 repetitions of each exercise every day. Participants received gait training and advice Total stretch time: 6 min x 7 d x 4 weeks = 2.8 h over a 4-week period
Outcomes	**Outcomes included in this review:** • Ankle dorsiflexion angle at peak baseline torque with knee straight (degrees) • Pain in standing with equal weight distribution (VAS) • Perceived disability (Lower Extremity Functional Score) • Return to work (VAS) **Other outcomes:** Dorsiflexion angle at peak baseline torque with knee bent, peak ankle dorsiflexion ROM with knee straight, peak ankle dorsiflexion ROM with knee bent, measures of ankle stiffness with knee straight, measures of ankle stiffness with knee bent, preload co-efficient with knee straight, preload co-efficient with knee bent, ankle torque at the peak baseline dorsiflexion angle with knee straight, ankle torque at the peak baseline dorsiflexion angle with knee bent, pain during stair descent, perceived adverse effects of treatment, return to usual sport and leisure activities, speed when walking, step length asymmetry, stepping rate when stair climbing, global perception of effect of treatment, satisfaction with treatment, duration of PT treatment **Time points included in this review:** Outcomes measured at 4 weeks (end of intervention) and 3 months (2 months after end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	

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Moseley 2005 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quote: "...subjects were randomly allocated into 1 of 3 groups… using a procedure that was stratified and blocked by site", p 1119 Comment: Insufficient detail reported.
Allocation concealment (selection bias)	Low risk	Quote: "...the randomization sequence was concealed by using consecutively numbered, sealed, opaque envelopes", p 1119
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...all measurements were made by assessors who were blind to group allocation", p 1112
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 11/150 (7%) dropouts at 4 week assessment, 16/150 (11%) dropouts at 3 month assessment
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Paul 2014

Methods	**Design**: Randomised parallel-group study
Participants	**Health condition**: Adults with adhesive capsulitis (frozen shoulder) **Sample size**: Experimental group: 50, Control group: 50 **Setting, Country**: Outpatient clinic, India **Joint of interest**: Shoulder **Inclusion criteria**: • Restriction of shoulder movements • Shoulder pain at night that often disturbed sleep • Guarded shoulder movements

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	• Difficulty in reaching behind the ear • Reduced arm swing with walking • Rounded shoulders and stooped posture • Ability to complete questionnaires **Exclusion criteria**: • Recent joint infection or surgery (less than 6 months) • History of shoulder subluxation, dislocation, or ligamentous injury • Shoulder arthroplasty • Shoulder impingement syndrome • Trigger points in the upper trapezius • Recent trauma **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 49 years (6), Control group: 53 years (7) **Gender**: Experimental group: 36% female, Control group: 34% female
Interventions	**Groups included in this review:** ***Experimental group*** : ***Stretch with countertraction device and usual care*** Participants received a shoulder stretch using an overhead device that provided a weighted shoulder countertraction (3 kg distracted load). This was administered during shoulder mobilisation. Participants also received usual care (details below) Total stretch time: 10 min x 5 d x 2 weeks = 1.7 h over a 2-week period ***Control group : Usual care*** Participants received physiotherapy which consisted of heat prior to shoulder mobilisation, mobilisation to improve flexion & abduction range, and electrotherapy (ultrasound or shortwave diathermy) ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Shoulder flexion (degrees) • Pain (VAS) **Other outcomes**: shoulder abduction, shoulder function (Oxford Shoulder Score) **Time points included in this review**: Outcomes measured at 2 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "...computer generated", p 2263
Allocation concealment (selection bias)	Low risk	Quote: "...based on a sealed-envelope system", p 2263

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Paul 2014 (*Continued*)

Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "The outcomes were recorded by an independent outcome assessment trained physiotherapist (DJ), who was not involved in the intervention procedures and also was unaware of participants allocated groups", p 2265
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "The outcomes were measured and calculated after the intervention period of 2 weeks and no participants dropped out of the study", p 2265
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Unclear risk	Comment: Insufficient detail provided

Refshauge 2006

Methods	**Design:** Randomised within-subjects cross-over study
Participants	**Health condition:** Children and young adults with Charcot-Marie-Tooth disease **Sample size:** Experimental group: 14 legs, Control group: 14 legs **Setting, Country:** Outpatient clinic, Australia **Joint of interest:** Ankle **Inclusion criteria:** • Charcot-Marie-Tooth disease Type 1A • Restricted range of passive dorsiflexion in both ankles (≤ 15° dorsiflexion from plantargrade) **Exclusion criteria:** • Previous surgery to either foot • Previous recent ankle sprain or fracture of either leg • Undergone any physiotherapy intervention or stretching programme within the last 6 months • Older than 30 years of age **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 15 years (8), Control group: 15 years (8) **Gender:** Experimental group: 57% female, Control group: 57% female

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Interventions	**Groups included in this review:** ***Experimental group: Night splint*** [1] Participants wore a pre-formed splint which was adjusted into dorsiflexion by the treating physiotherapist until participants felt a stretch in their calf muscles which could be tolerated during sleeping. The amount of dorsiflexion was increased if the stretch was felt to be insufficient. Participants were instructed to wear the splint for the whole night. Participants were also requested to avoid performing additional stretches or exercises that deviated from their normal routine Total stretch time: (4-9 h) x 7 d x 6 weeks = 168 h-78 h over a 6-week period ***Control group: No splint*** [1] Participants were requested to avoid performing additional stretches or exercises that deviated from their normal routine ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive ankle dorsiflexion **Other outcomes:** Passive ankle eversion, isometric ankle dorsiflexion strength, isometric ankle eversion strength, isometric ankle inversion strength **Time points included in this review:** Outcomes measured at 6 weeks (end of 1st period) **Other time points:** Outcomes also measured at baseline, 12 weeks (end of 2nd period) and 26 weeks
Notes	[1]Only includes details of the first period of the cross-over

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...at the initial assessment, the treating physiotherapist randomly selected the leg to be splinted first by tossing a coin after baseline measurements were completed", p 194
Allocation concealment (selection bias)	High risk	Quote: "...at the initial assessment, the treating physiotherapist randomly selected the leg to be splinted first by tossing a coin after baseline measurements were completed", p 194
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...the same assessor, who was blinded to group allocation, made all measurements for each participant", p 194

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Refshauge 2006 (*Continued*)

Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 4/56 (7%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Rose 2010

Methods	Randomised parallel-group study
Participants	**Health condition**: Children and young adults with Charcot-Marie-Tooth disease and restricted ankle dorsiflexion range **Sample size**: Experimental group: 15, Control group: 15 **Setting, Country**: Outpatient clinic, Australia **Joint of interest**: Ankle **Inclusion criteria**: • 7-20 years • Confirmed diagnosis of Charcot-Marie-Tooth • Consistent clinical phenotype • Confirmatory electrophysiological testing • Restricted ROM in one or both ankles (< 25°) **Exclusion criteria**: • Ankle sprain or fracture in past 3 months • Undergone foot or ankle surgery • Enrolled in another trial • Participated in a stretching programme in last 2 months **Existing contracture, at risk of contracture, or combination of both**: Participants had existing contracture **Mean age (SD):** Experimental group: 10 years (4), Control group: 11 years (3) **Gender**: Experimental group: 60% female, Control group: 47% female
Interventions	**Groups included in this review:** ***Experimental group : Night cast for 4 weeks followed by stretches in standing for 4 weeks*** Participants wore a fibreglass cast with the ankle positioned in dorsiflexion (knee not included). The casts were bivalved and applied only at night for the first 4 weeks. The casts were remade after 2 weeks. At 4 weeks, the stretches were administered in standing using 2 types of stretches. Each stretch was held for 1 min and performed 3 times a day Total stretch time: (6-10 h x 7 d x 4 weeks) + (1 min x 6 times per day x 7 d x 4 weeks) = 170.8-282.2 h over an 8-week period ***Control group : No intervention*** Participants received no intervention.

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Rose 2010 (*Continued*)

	Other groups *:* Nil
Outcomes	**Outcomes included in this review:** 1. Ankle dorsiflexion during a lunge test (degrees) 2. Speed of preferred walking (m/sec) **Other outcomes**: Foot Posture Index (points), Patient Specific Functional Scale (points) , standing up speed (stands/sec), speed of fast walking (m/sec), speed of ascending stairs (stairs/sec), balance with feet together (sec), balance with feet toe to heel (sec), balance in tandem stance (sec), number of falls (no.) **Time points included in this review**: Outcomes measured at 8 weeks (end of intervention). **Other time points:** Outcomes also measured at baseline and 4 weeks.
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "The randomisation sequence was computer-generated...", p 114
Allocation concealment (selection bias)	Low risk	Quote: "…telephoned the administrative assistant to obtain the participant's random allocation..." p 114
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...assessor blinding...", p 113
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: Table 2 - all outcomes at all end-points
Selective reporting (reporting bias)	Low risk	Comment: Table 2 - all outcomes at all end-points
Other bias	Low risk	Comment: Appears free of other bias

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Seeger 1987

Methods	**Design:** Randomised within-subjects study
Participants	**Health condition:** Adults with systemic sclerosis (scleroderma) **Sample size:** Experimental group: 19 hands, Control group: 19 hands **Setting, Country:** Outpatient clinic, USA **Joint of interest:** Proximal interphalangeal **Inclusion criteria:** • Symmetrical and progressive systemic sclerosis • Involvement of the hands with contractures of the interphalangeal joints **Exclusion criteria:** • Skin ulcers of the fingers or hands severe enough to interfere with splinting **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (range):** Experimental group: 48 years (31-61)[1], Control group: 48 years (31-61)[1] **Gender:** Experimental group: 100% female[1], Control group: 100% female[1], both groups including dropouts: 89% female
Interventions	**Groups included in this review:** ***Experimental group: Splint*** Participants wore a dynamic splint on the experimental hand which provided a sustained stretch into extension on the interphalangeal and metacarpophalangeal joints Total stretch time: 8 h x 7 d x 8 weeks = 448 h over an 8-week period ***Control group: No splint*** Participants did not wear a splint on the control hand ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Combined proximal interphalangeal (PIP) passive extension (degrees) **Other outcomes:** Combined proximal interphalangeal active extension, index finger proximal interphalangeal passive extension, index finger proximal interphalangeal active extension, middle finger proximal interphalangeal passive extension, middle finger proximal interphalangeal active extension, ring finger proximal interphalangeal passive extension, ring finger proximal interphalangeal active extension, little finger proximal interphalangeal passive extension, little finger proximal interphalangeal active extension **Time points included in this review:** Outcomes measured at 2 months (end of intervention) **Other time points:** Outcomes also measured at baseline and 1 month
Notes	[1] Excludes dropouts

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...random number table", p 119

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Seeger 1987 (*Continued*)

Allocation concealment (selection bias)	High risk	Comment: Insufficient detail reported in paper. Correspondence with study author revealed that allocation was not concealed
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...measurements were done by the same evaluator who was blind to the study", p 119
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Quote: "...2 were dropped for non-compliance", p 120 Comment: 12/19 (63%) dropouts for PROM outcome
Selective reporting (reporting bias)	High risk	Comment: At least 8 ROM outcomes were measured but only 2 were reported
Other bias	Low risk	Comment: Appears free of other bias

Sheehan 2006

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 6, Control group: 8 **Setting, Country:** Inpatient and outpatient rehabilitation centres, Australia **Joint of interest:** Wrist (finger flexors) **Inclusion criteria:** • Stroke-related resistance of affected hand • Not receiving other therapy for affected arm • No history of fracture or other pre-existing condition that limited range of movement of the affected hand • No functional use of affected hand • Clinically detectable spasticity (grade 2-3) in the affected hand as measured by the modified Ashworth scale • Ability to provide consent • No comorbidities that could confound the findings **Exclusion criteria:** Not reported **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 74 years (8.7)[1], Control group: 70 years (7.5)[1]

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	Gender: Experimental group: 0% female, Control group: 17% female[1]
Interventions	**Groups included in this review:** ***Experimental group: Splint on 2nd week (Group 2)*** Participants wore a thermoplastic resting splint during the 2nd week (i.e. participants wore the splint from the 2nd week to the 7th week). Participants received no other upper limb treatment interventions Total stretch time: 8 h[1] x 7 d x 1 week = 56 h over a 1-week period ***Control group: No splint on 2nd week (Group 1)*** Participants did not wear a thermoplastic resting splint during the 2nd week (i.e. participants wore the splint from the 3rd week to the 7th week). Participants received no other upper limb treatment interventions ***Other groups*** **:** Nil
Outcomes	**Outcomes included in this review:** • Resistance at 20° extension (N) **Other outcomes:** Resistance at 10° wrist extension, resistance at 0° wrist extension, resistance at 10° wrist flexion, resistance at 20° wrist flexion, rate of change of resistance **Time points included in this review:** Outcomes measured at 2 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline and 7 weeks
Notes	[1]Data obtained from correspondence with study author

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "...random numbers table", p 1033
Allocation concealment (selection bias)	Low risk	Quote: "...the slips of paper containing the random numbers were replaced in a black bag that was kept in a locked drawer in the independent clinician's desk...with vision occluded, the independent clinician drew a number from the bag and the participant was allocated to the group", p 1033
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "The researcher was not involved in the random allocation of subjects and was thus blinded to group allocation" (correspondence with study author) Comment: Insufficient detail reported in paper. Correspondence with study author

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Sheehan 2006 (*Continued*)

		revealed that assessors were blinded to group allocation
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 2/14 (14%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	Low risk	Comment: Appears free of other bias

Steffen 1995

Methods	**Design:** Randomised within-subjects study
Participants	**Health condition:** Elderly people with bilateral knee contractures **Sample size:** Experimental group: 14, Control group: 14 **Setting, Country:** Nursing homes, USA **Joint of interest:** Knee **Inclusion criteria:** • Nursing home residents with bilateral knee flexion contractures of ≥10° **Exclusion criteria:** Not reported **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture **Mean age (SD):** Experimental group: 86 years (7), Control group: 86 years (7) **Gender:** Experimental group: 79% female, Control group: 79% female
Interventions	**Groups included in this review:** ***Experimental group: Knee splint (prolonged stretch) plus passive ROM exercises and manually administered stretches*** Participants wore a knee extension splint from the second month of the study through to the seventh month (total = 6 months). The tension setting on the splint was initially 0 and progressed to 6 (62.2 kg-cm) between weeks 2 and 5 of the study. Participants also received passive ROM and manually administered stretches (details below) Total stretch time: 3 h x 5 d x 26 weeks = 390 h over a 26-week period ***Control group: Passive ROM exercises and manually administered stretches*** Each participant received passive ROM exercises and manually administered stretches to both lower extremities twice a week by on-site physiotherapists trained in the standardised protocol ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive knee extension (degrees) **Other outcomes:** Passive hip extension, passive ankle dorsiflexion, torque required to

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	maintain maximum passive knee extension **Time points included in this review:** Outcomes measured at 7 months (end of intervention). **Other time points:** Outcomes also measured at baseline, 2 weeks, 4 weeks, 2 months, 3 months, 4 months, 5 months and 6 months
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Quote: "Use of the prolonged stretch was alternately assigned to the right or left knee", p 889
Allocation concealment (selection bias)	High risk	Comment: Alternate assignment means allocation was not concealed
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "The physiotherapists performing the measurements were not aware of the side of the experimental treatments", p 888
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 10/28 (36%) dropouts reported
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported
Other bias	High risk	Quote: "All the subjects in two of the nursing homes were checked for fit by the designer of the splint, who also owns the company that makes the splint", p 889

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Turton 2005

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults with stroke **Sample size:** Experimental group: 14, Control group: 15 **Setting, Country:** Hospital inpatients, UK **Joint of interest:** Wrist and shoulder **Inclusion criteria:** • Admitted to stroke ward • Primary diagnosis of first unilateral stroke • Within 4 weeks of onset • Able to give informed consent • Lost function in the affected arm and hand **Exclusion criteria:** • Arthritis or arm pain before the stroke • Poor comprehension • Confusion • Dementia • Medically unfit for the treatment **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 70 years (10)[1], Control group: 66 years (14)[1] **Gender:** Experimental group: 31% female[2], Control group: 33% female[2]
Interventions	**Groups included in this review:** ***Experimental group: Stretch plus usual care*** Participants received two 30-min sessions of positioning in each of these positions: Position 1 - Wrist and finger stretch using a hinged board Position 2 - Shoulder in abduction and some external rotation Participants also received usual care (details below) Total stretch time (maximum) = 2 wrist stretches x 30 min x 7 d x 12 weeks = 84 h[3] ***Control group: Usual care*** All participants received the standard arm care which did not include sustained stretches. The affected arm was supported on a Bexhill arm support or pillow in sitting ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Passive wrist extension of the affected arm (degrees) **Other outcomes:** Passive wrist extension contracture (unaffected minus affected), passive shoulder external rotation - affected, passive shoulder external rotation contracture (unaffected minus affected), active wrist extension ROM - affected, active shoulder external rotation ROM - affected **Time points included in this review:** Outcomes measured at 12 weeks post-stroke[4] **Other time points:** Outcomes also measured at 4 weeks post-stroke[5] and 8 weeks[4]
Notes	[1]Mean age (SD) of participants at 4 weeks post stroke. Study authors did not measure participants at point of randomisation [2]Gender of participants at 4 weeks post stroke. Study authors did not measure participants at point of randomisation [3]Total stretch time varied between participants because of varying recruitment timing

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	and discharge timing. The intervention was also stopped if participants reached a certain criteria for arm function or if they reached 12 weeks post-stroke [4]Considerable variation in time since last stretch intervention ranging from less than 24 h to greater than 1 week [5]At least 4 participants were already randomised prior to this first measure

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "...computer-generated sequence for group allocation", p 601
Allocation concealment (selection bias)	Low risk	Quote: "...group allocation was kept by a person who was independent of the recruitment process", p 601 Comment: Off-site allocation
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Low risk	Quote: "...readings were taken by the assistant who was (when possible) kept blind to the subject s allocation", p 604 Comment: Insufficient detail reported in paper. Correspondence with study author revealed that blinding of assessors failed on only 3 occasions
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: 6/29 (21%) dropouts for 12 week assessment
Selective reporting (reporting bias)	High risk	Comment: No outcomes reported for active ROM measures
Other bias	High risk	Comment: No standard treatment protocol. Experimental participants given varying amounts of treatment dependent on length of stay or arm function

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Zenios 2002

Methods	**Design:** Randomised parallel-group study
Participants	**Health condition:** Adults following total knee replacement **Sample size:** Experimental group: 42, Control group: 39 **Setting, Country:** Acute hospital, UK **Joint of interest:** Knee **Inclusion criteria:** • Total knee replacement with patellar resurfacing **Exclusion criteria:** • One-stage bilateral knee replacement • Unicondylar knee replacement • Long term anticoagulant therapy **Existing contracture, at risk of contracture, or combination of both:** Participants had existing contracture and were at risk of developing contracture **Mean age (SD):** Experimental group: 71 years (7), Control group: 71 years (8) **Gender:** Experimental group: 69% female, Control group: 67% female
Interventions	**Groups included in this review:** ***Experimental group: Splint*** Participants' knees were splinted into extension using a cricket pad splint in the early postoperative period. The splint was removed for the participants to do physiotherapy exercises twice a day. Splints were removed when the participant could straight leg raise Total stretch time: 23 h x 3 d = 69 h over a 3-day period ***Control group: No splint*** Participants had a wool and crepe bandage applied around their knee and were allowed to fully mobilise from the first day. The bandage was removed at 48 hours post-op. Participants in this group, in addition to the twice a day physiotherapy regime were encouraged to actively flex the knee from the first postoperative day ***Other groups:*** Nil
Outcomes	**Outcomes included in this review:** • Knee fixed flexion (passive knee extension ROM; degrees) **Other outcomes:** Knee flexion ROM, time to straight leg raise, wound drainage, amount of analgesia required **Time points included in this review:** Outcomes measured at 6 weeks (end of intervention) **Other time points:** Outcomes also measured at baseline and 5 days post-op[1]
Notes	[1] Unclear whether the intervention was still continuing in some participants at the 5-day outcome

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomised into two groups", p 225 Comment: Insufficient detail reported

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Zenios 2002 (*Continued*)

Allocation concealment (selection bias)	Unclear risk	Quote: "...using a sealed envelope technique", p 225 Comment: Insufficient detail reported
Blinding (performance bias and detection bias) Therapists	High risk	Comment: Not possible to blind participants or therapists
Blinding of outcome assessors (detection bias) - objective outcomes All outcomes	Unclear risk	Quote: "...measurements were recorded by an independent observer", p 226 Comment: Insufficient detail reported
Blinding of outcome assessors (detection bias) - self-reported outcomes All outcomes	High risk	Comment: Not possible to blind participants
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: 2/81 (2%) dropouts
Selective reporting (reporting bias)	Low risk	Comment: All pre-stated outcomes were reported. Details of secondary outcomes are unclear
Other bias	Low risk	Comment: Appears free of other bias

FMA: Fugl-Meyer Assessment; ITT: intention-to-treat; MAS: Motor Assessment Scale; ROM: range of movement; VAS: Visual Analogue Scale

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Adams 2008	Did not measure joint mobility
Al-Oraibi 2013	Stretch compared to serial casting. Unable to isolate the effects of stretch
Ayala 2010	Not a RCT.
Baker 2007	Correspondence with the study author revealed that participants received a confounding intervention. Compared stretch to home exercises. Different home exercises were given to each group
Baker 2012	Participants were not at risk of contracture
Bek 2002	Stretch compared to two other stretch interventions. Unable to isolate the effects of stretch

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(*Continued*)

Bertoti 1986	Did not measure joint mobility
Bottos 2003	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Brar 1991	Did not measure joint mobility
Brouwer 2000	Not a RCT
Buckon 2001	Stretch compared to two other stretch interventions. Unable to isolate the effects of stretch
Budiman-Mak 1995	Not a stretch intervention
Bury 1995	Splint not applied for the purpose of maintaining or increasing joint mobility
Camin 2004	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Cantarero-Villanueva 2011	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Carda 2011	Stretch compared to two other stretch interventions. Unable to isolate the effects of stretch
Chadchavalpanichaya 2010	Stretch compared to two other stretch interventions. Unable to isolate the effects of stretch
Chow 2010	Stretch compared to two other stretch interventions. Unable to isolate the effects of stretch
Collis 2013a	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Conrad 1996	Not a stretch intervention
Corry 1998	Compared casting and botulinum toxin. No botulinum toxin given to casting group. Unable to isolate the effects of stretch
Czaprowski 2013	Stretch compared to two other stretch interventions. Unable to isolate the effects of stretch
De Jong 2013	Stretch applied on one occasion only
Desloovere 2001	Compared different timings of same stretch before and after botulinum toxin. Unable to isolate effects of stretch
Dinh 2011	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Duerden 2009	This study was registered and noted as a study in progress in the 2009 version of this Cochrane review. However, according to the clinical trials registry, it never started and has since been withdrawn
Elliott 2011	Did not measure joint mobility
Farina 2008	Did not measure joint mobility

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(*Continued*)

Feland 2001	Participants were not at risk of contracture
Flett 1999	Compared casting to botulinum toxin. No botulinum toxin given to casting group. Unable to isolate the effects of stretch
Flowers 1994	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Fogelman 2013	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Gajdosik 2005	Participants were not at risk of contracture
Gallon 2011	Participants were not at risk of contracture
Gaspar 2009	Not a RCT
Gbenedio	Participants were not at risk of contracture
Gillmore 1995	Participants were not at risk of contracture
Glasgow 2003	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Gomes 2014	Stretch compared to massage. Unable to isolate the effects of stretch
Gonzalez-Rave 2012	Participants were not at risk of contracture
Gracies 2000	Splint applied on one occasion only
Hale 1995	Not a RCT
Harvey 2007	Not a stretch intervention
Hayek 2010	Not a RCT
Hermann 2013	Did not measure joint mobility
Hobbelen 2003	Not a stretch intervention
Hogan 2001	Orthosis applied on one occasion only
Jones 2002	Compared stretch to muscle strengthening. No muscle strengthening performed by stretch group. Unable to isolate the effects of stretch
Jung 2011	Did not measure joint mobility
Kanellopoulos 2009	Not a RCT
Kappetijn 2014	Not a RCT

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(*Continued*)

Kerem 2001	Not a RCT
Kilbreath 2006	Compared resistance and stretching exercises to no exercises. Unable to isolate the effects of stretch
Kilgour 2008	Not a stretch intervention, involved primarily active exercises
Kilmartin 1994	Did not measure joint mobility
Kim 2013	Did not measure joint mobility
Lauridsen 2005	Not a stretch intervention
Law 1997	Compared intensive neurodevelopmental therapy plus casting to regular occupational therapy. Unable to isolate the effects of casting
Li-Tsang 2002	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Light 1984	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Malcus 1992	Did not measure joint mobility
Maloney Backstrom 1995	Participants were not at risk of contracture
Marschall 1999	Participants were not at risk of contracture
McPherson 1985	Stretch compared to passive movements. Unable to isolate the effects of stretch
Mikkelsen 2003	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Miura 2005	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Montero Camara 2011	Stretch compared to another stretch intervention. Participants were not at risk of contracture
Morris 1991	Stretch applied on one occasion only
Moseley 2008	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Newman 2007	Compared different timings of the same stretch intervention. Unable to isolate the effects of stretch
Ott 1998	Participants were not at risk of contracture
Park 2010	Not a RCT
Pickenbrock 2015	Not a stretch intervention
Putt 2008	Participants were not at risk of contracture

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(*Continued*)

Reiter 1998	Compared botulinum toxin to botulinum toxin plus taping. Different botulinum toxin dosages and injection sites were used between groups. Unable to isolate the effects of taping
Risberg 1999	Not a stretch intervention
Robinson 2008	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Rose 1987	Splint applied on one occasion only
Rose 2007	Not a RCT
Rydwik 2006	Not a stretch intervention
Santamato 2015	Stretch compared to another stretch intervention. Unable to isolate the effects of stretch
Thibaut 2015	Stretch applied on one occasion only
Vliet 2009	Not a RCT
Watt 2011	Participants were not at risk of contracture
Watt 2014	Not a RCT
Winters 2004	Participants were not at risk of contracture

RCT: randomised controlled trial

Characteristics of studies awaiting assessment *[ordered by study ID]*

Amirsalari 2011

Methods	Published in Arabic - awaiting translation. Unable to determine if eligible
Participants	Unable to determine
Interventions	Unable to determine
Outcomes	Unable to determine
Notes	Unable to determine

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Dalvand 2012

Methods	Published in Arabic - awaiting translation. Unable to determine if eligible
Participants	Unable to determine
Interventions	Unable to determine
Outcomes	Unable to determine
Notes	Unable to determine

Evans 1994

Methods	Unable to attain full text. Unable to determine if eligible
Participants	Unable to determine
Interventions	Unable to determine
Outcomes	Unable to determine
Notes	Unable to determine

Javanshir 2010

Methods	Published in Arabic - awaiting translation. Unable to determine if eligible
Participants	Unable to determine
Interventions	Unable to determine
Outcomes	Unable to determine
Notes	Unable to determine

Lagalla 1997

Methods	Published in Italian - awaiting translation. Unable to determine if eligible
Participants	Unable to determine
Interventions	Unable to determine
Outcomes	Unable to determine
Notes	Unable to determine

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Tutunchi 2011

Methods	
Participants	
Interventions	
Outcomes	
Notes	

Characteristics of ongoing studies *[ordered by study ID]*

ACTRN12613000690752

Trial name or title	
Methods	
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	
Notes	

ACTRN12616000230459

Trial name or title	
Methods	
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	
Notes	

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Maas 2012

Trial name or title	Splint: the efficacy of orthotic management in rest to prevent equinus in children with cerebral palsy, a randomised controlled trial
Methods	RCT
Participants	Children with cerebral palsy
Interventions	Orthoses worn for 1 year to prevent a decrease in ROM in the ankle
Outcomes	Ankle dorsiflexion
Starting date	January 2010
Contact information	Josina C Maas. Department of Rehabilitation Medicine and the EGMO + Institute for Health and Care Research and Research Institute MOVE, VU University Medical Center, De Boelelaan 1117, 1081 HV Amsterdam, The Netherlands, jc.maas@vumc.nl
Notes	The published trial protocol indicates that the trial will be completed by December 2012. We contacted the study authors in May 2016 to clarify status of the trial but have not had a response

NCT02638480

Trial name or title	
Methods	
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	
Notes	

ROM: range of motion

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DATA AND ANALYSES

Comparison 1. Joint mobility - short-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	18	549	Mean Difference (IV, Random, 95% CI)	1.81 [0.45, 3.17]
1.1 Stroke	11	295	Mean Difference (IV, Random, 95% CI)	0.56 [-1.56, 2.68]
1.2 Charcot-Marie-Tooth disease	2	82	Mean Difference (IV, Random, 95% CI)	2.27 [0.16, 4.38]
1.3 Acquired brain injury	3	35	Mean Difference (IV, Random, 95% CI)	8.48 [0.60, 16.36]
1.4 Spinal cord injury	4	137	Mean Difference (IV, Random, 95% CI)	1.42 [-0.54, 3.37]
2 Non-neurological conditions	18	865	Std. Mean Difference (IV, Random, 95% CI)	0.16 [-0.00, 0.33]
2.1 Frail elderly	2	60	Std. Mean Difference (IV, Random, 95% CI)	0.23 [-0.28, 0.74]
2.2 Ankle fracture	1	93	Std. Mean Difference (IV, Random, 95% CI)	-0.05 [-0.46, 0.35]
2.3 Anklylosing spondylitis	1	39	Std. Mean Difference (IV, Random, 95% CI)	0.63 [-0.07, 1.32]
2.4 Oral submucous fibrosis	1	24	Std. Mean Difference (IV, Random, 95% CI)	0.83 [-0.05, 1.72]
2.5 Post-radiation therapy to breast	1	56	Std. Mean Difference (IV, Random, 95% CI)	0.05 [-0.47, 0.58]
2.6 Post-radiation therapy to jaw	1	14	Std. Mean Difference (IV, Random, 95% CI)	1.54 [0.25, 2.82]
2.7 Progressive systemic sclerosis	1	14	Std. Mean Difference (IV, Random, 95% CI)	0.78 [-0.32, 1.88]
2.8 Total knee replacement	1	55	Std. Mean Difference (IV, Random, 95% CI)	-0.19 [-0.72, 0.34]
2.9 Arthritis	1	36	Std. Mean Difference (IV, Random, 95% CI)	0.41 [-0.25, 1.07]
2.10 Dupuytren's contractures	3	226	Std. Mean Difference (IV, Random, 95% CI)	0.09 [-0.27, 0.45]
2.11 Shoulder adhesive capsulitis/frozen shoulder	1	100	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.67, 0.11]
2.12 Hallux limitus	1	48	Std. Mean Difference (IV, Random, 95% CI)	0.43 [-0.14, 1.01]
2.13 Wrist fracture	1	36	Std. Mean Difference (IV, Random, 95% CI)	0.24 [-0.41, 0.90]
2.14 Burns	2	64	Std. Mean Difference (IV, Random, 95% CI)	0.14 [-0.35, 0.63]

Comparison 2. Joint mobility - long-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	8	211	Mean Difference (IV, Random, 95% CI)	0.73 [-1.37, 2.82]
1.1 Stroke	4	134	Mean Difference (IV, Random, 95% CI)	-0.32 [-4.09, 3.44]
1.2 Cerebral palsy	2	39	Mean Difference (IV, Random, 95% CI)	1.37 [-2.05, 4.79]
1.3 Spinal cord injury	1	28	Mean Difference (IV, Random, 95% CI)	0.0 [-3.05, 3.05]
1.4 Acquired brain injury	1	10	Mean Difference (IV, Random, 95% CI)	10.42 [0.62, 20.22]
2 Non-neurological conditions	6	438	Std. Mean Difference (IV, Random, 95% CI)	-0.10 [-0.36, 0.16]
2.1 ACL reconstruction	1	36	Std. Mean Difference (IV, Random, 95% CI)	0.12 [-0.54, 0.77]
2.2 Ankle fracture	1	90	Std. Mean Difference (IV, Random, 95% CI)	-0.20 [-0.62, 0.21]
2.3 Total knee replacement	1	79	Std. Mean Difference (IV, Random, 95% CI)	-0.36 [-0.80, 0.09]

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2.4 Dupuytren's contracture	2	201	Std. Mean Difference (IV, Random, 95% CI)	-0.19 [-0.47, 0.09]
2.5 Wrist fracture	1	32	Std. Mean Difference (IV, Random, 95% CI)	0.80 [0.07, 1.52]

Comparison 3. Quality of life - short-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-neurological conditions	2	97	Std. Mean Difference (IV, Random, 95% CI)	0.31 [-0.09, 0.71]
1.1 Post-radiation therapy to breast	1	57	Std. Mean Difference (IV, Random, 95% CI)	0.15 [-0.37, 0.67]
1.2 Burns	1	40	Std. Mean Difference (IV, Random, 95% CI)	0.55 [-0.08, 1.18]

Comparison 4. Pain - short-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	5	174	Std. Mean Difference (IV, Random, 95% CI)	0.20 [-0.10, 0.50]
1.1 Stroke	4	135	Std. Mean Difference (IV, Random, 95% CI)	0.31 [-0.03, 0.66]
1.2 Spinal cord injury	1	39	Std. Mean Difference (IV, Random, 95% CI)	-0.18 [-0.81, 0.45]
2 Non-neurological conditions	7	422	Std. Mean Difference (IV, Random, 95% CI)	-0.17 [-0.43, 0.10]
2.1 Ankle fracture	1	93	Std. Mean Difference (IV, Random, 95% CI)	0.0 [-0.41, 0.41]
2.2 Frail elderly	1	24	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-1.10, 0.51]
2.3 Post-radiotherapy to breast	1	55	Std. Mean Difference (IV, Random, 95% CI)	-0.10 [-0.63, 0.43]
2.4 Arthritis	1	36	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-0.96, 0.35]
2.5 Shoulder adhesive capsulitis/frozen shoulder	2	160	Std. Mean Difference (IV, Random, 95% CI)	-0.20 [-1.17, 0.78]
2.6 Dupuytren's contracture	1	54	Std. Mean Difference (IV, Random, 95% CI)	-0.09 [-0.62, 0.44]

Comparison 5. Pain - long-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	4	132	Std. Mean Difference (IV, Random, 95% CI)	0.03 [-0.41, 0.47]
1.1 Stroke	4	132	Std. Mean Difference (IV, Random, 95% CI)	0.03 [-0.41, 0.47]
2 Non-neurological conditions	2		Mean Difference (IV, Random, 95% CI)	Totals not selected
2.1 Ankle fracture	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
2.2 Shoulder adhesive capsulitis	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]

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Comparison 6. Activity limitations - short-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	7	237	Std. Mean Difference (IV, Random, 95% CI)	0.19 [-0.13, 0.52]
1.1 Stroke	5	170	Std. Mean Difference (IV, Random, 95% CI)	0.27 [-0.09, 0.63]
1.2 Cerebral palsy	1	37	Std. Mean Difference (IV, Random, 95% CI)	0.44 [-0.21, 1.09]
1.3 Charcot-Marie-Tooth disease	1	30	Std. Mean Difference (IV, Random, 95% CI)	-0.49 [-1.21, 0.24]
2 Non-neurological conditions	5	356	Std. Mean Difference (IV, Random, 95% CI)	0.09 [-0.17, 0.34]
2.1 Ankle fracture	1	93	Std. Mean Difference (IV, Random, 95% CI)	0.10 [-0.30, 0.51]
2.2 Arthritis	1	36	Std. Mean Difference (IV, Random, 95% CI)	0.47 [-0.20, 1.13]
2.3 Dupuytren's contracture	1	151	Std. Mean Difference (IV, Random, 95% CI)	-0.07 [-0.39, 0.25]
2.4 Wrist fracture	1	36	Std. Mean Difference (IV, Random, 95% CI)	-0.31 [-0.97, 0.35]
2.5 Burns	1	40	Std. Mean Difference (IV, Random, 95% CI)	0.51 [-0.12, 1.14]

Comparison 7. Activity limitations - long-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	6	191	Std. Mean Difference (IV, Random, 95% CI)	0.22 [-0.11, 0.56]
1.1 Stroke	4	136	Std. Mean Difference (IV, Random, 95% CI)	0.14 [-0.29, 0.58]
1.2 Cerebral palsy	2	55	Std. Mean Difference (IV, Random, 95% CI)	0.41 [-0.17, 1.00]
2 Non-neurological conditions	3	268	Std. Mean Difference (IV, Random, 95% CI)	-0.09 [-0.32, 0.15]
2.1 Ankle fracture	1	90	Std. Mean Difference (IV, Random, 95% CI)	-0.07 [-0.48, 0.35]
2.2 Dupuytren's contracture	1	146	Std. Mean Difference (IV, Random, 95% CI)	-0.08 [-0.41, 0.24]
2.3 Wrist fracture	1	32	Std. Mean Difference (IV, Random, 95% CI)	-0.16 [-0.86, 0.54]

Comparison 8. Participation restrictions - short-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-neurological conditions	2	129	Std. Mean Difference (IV, Random, 95% CI)	-0.22 [-0.57, 0.12]
1.1 Ankle fracture	1	93	Std. Mean Difference (IV, Random, 95% CI)	-0.31 [-0.72, 0.10]
1.2 Wrist fracture	1	36	Std. Mean Difference (IV, Random, 95% CI)	0.0 [-0.65, 0.65]

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Comparison 9. Participation restrictions - long-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Non-neurological conditions	2	122	Std. Mean Difference (IV, Random, 95% CI)	-0.15 [-0.60, 0.29]
1.1 Ankle fracture	1	90	Std. Mean Difference (IV, Random, 95% CI)	0.0 [-0.41, 0.41]
1.2 Wrist fracture	1	32	Std. Mean Difference (IV, Random, 95% CI)	-0.49 [-1.20, 0.22]

Comparison 10. Spasticity - short-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	6	144	Std. Mean Difference (IV, Random, 95% CI)	0.03 [-0.30, 0.36]
1.1 Stroke	5	134	Std. Mean Difference (IV, Random, 95% CI)	0.05 [-0.29, 0.39]
1.2 Acquired brain injury	1	10	Std. Mean Difference (IV, Random, 95% CI)	-0.27 [-1.55, 1.00]

Comparison 11. Spasticity - long-term effects following stretch

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Neurological conditions	3	73	Std. Mean Difference (IV, Random, 95% CI)	-0.34 [-0.81, 0.13]
1.1 Stroke	1	42	Std. Mean Difference (IV, Random, 95% CI)	-0.50 [-1.12, 0.11]
1.2 Cerebral palsy	1	21	Std. Mean Difference (IV, Random, 95% CI)	0.14 [-0.73, 1.00]
1.3 Traumatic brain injury	1	10	Std. Mean Difference (IV, Random, 95% CI)	-0.70 [-2.03, 0.62]

Comparison 12. Joint mobility - subgroup analyses

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Types of stretch intervention	36	1470	Mean Difference (IV, Random, 95% CI)	1.07 [0.03, 2.10]
1.1 Cast	3	57	Mean Difference (IV, Random, 95% CI)	4.59 [-2.60, 11.78]
1.2 Splint	17	787	Mean Difference (IV, Random, 95% CI)	0.27 [-1.02, 1.55]
1.3 Self-administered	2	75	Mean Difference (IV, Random, 95% CI)	3.07 [0.19, 5.94]
1.4 Positioning	7	165	Mean Difference (IV, Random, 95% CI)	2.80 [-2.73, 8.33]
1.5 Other sustained passive stretch	7	386	Mean Difference (IV, Random, 95% CI)	0.77 [-1.07, 2.61]
2 Large versus small joints	36	1467	Mean Difference (IV, Random, 95% CI)	1.03 [-0.02, 2.09]
2.1 Large joints	16	645	Mean Difference (IV, Random, 95% CI)	0.57 [-0.89, 2.03]
2.2 Small joints	20	822	Mean Difference (IV, Random, 95% CI)	1.44 [-0.11, 3.00]
3 Influence of discomfort	36	1470	Mean Difference (IV, Random, 95% CI)	1.07 [0.01, 2.13]

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3.1 Measurements influenced by discomfort	25	1009	Mean Difference (IV, Random, 95% CI)	1.19 [-0.41, 2.78]
3.2 Measurements not influenced by discomfort	11	461	Mean Difference (IV, Random, 95% CI)	1.05 [-0.42, 2.52]
4 Joint mobility measured less than one day versus more than one day	34	1400	Mean Difference (IV, Fixed, 95% CI)	1.17 [0.50, 1.85]
4.1 Less than one day	28	1155	Mean Difference (IV, Fixed, 95% CI)	1.10 [0.20, 2.00]
4.2 More than one day	7	245	Mean Difference (IV, Fixed, 95% CI)	1.26 [0.24, 2.28]

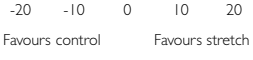
Analysis 1.1. Comparison 1 Joint mobility - short-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 1 Joint mobility - short-term effects following stretch

Outcome: 1 Neurological conditions

Study or subgroup	Stretch N	Stretch Mean(SD)[degrees]	Control N	Control Mean(SD)[degrees]	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Stroke							
Ada 2005	15	-6.1 (11.2)	16	-17.9 (19.6)		1.4 %	11.80 [0.65, 22.95]
Basaran 2012	13	52.31 (19.11)	12	52.5 (19.48)		0.8 %	-0.19 [-15.34, 14.96]
De Jong 2006	4	76 (16.8)	6	61.67 (8)		0.6 %	14.33 [-3.33, 31.99]
Dean 2000	10	-11 (15.60047)	13	-14 (17.78728)		0.9 %	3.00 [-10.67, 16.67]
Gustafsson 2006	17	50.3 (15.7)	15	49 (24.1)		0.9 %	1.30 [-13.00, 15.60]
Harvey 2006	0.857143 (2.478479)		7	7 1.86 (3.236694)		9.3 %	-1.00 [-4.02, 2.02]
Horsley 2007	20	3.8 (10.16472)	20	0 (10.16472)		3.7 %	3.80 [-2.50, 10.10]
Lai 2009	23.66667 (28.27333)		15	15 14.4 (26.8775)		0.5 %	9.27 [-10.47, 29.01]
Lannin 2003a	14	1 (6.614547)	11	0 (5.863169)		5.3 %	1.00 [-3.90, 5.90]
Lannin 2007a	21	0 (6.034517)	21	1.3 (6.034517)		7.7 %	-1.30 [-4.95, 2.35]
Turton 2005	12	-15.5 (18.7)	11	-9.9 (13.9)		1.0 %	-5.60 [-18.99, 7.79]
Subtotal (95% CI)	**148**		**147**			**31.9 %**	**0.56 [-1.56, 2.68]**
Heterogeneity: Tau² = 1.13; Chi² = 10.93, df = 10 (P = 0.36); I² =9%							
Test for overall effect: Z = 0.52 (P = 0.60)							
2 Charcot-Marie-Tooth disease							
Refshauge 2006	26	1 (6.44)	26	0 (6.44)		8.0 %	1.00 [-2.50, 4.50]
Rose 2010	15	5 (3.7)	15	2 (3.7)		10.4 %	3.00 [0.35, 5.65]



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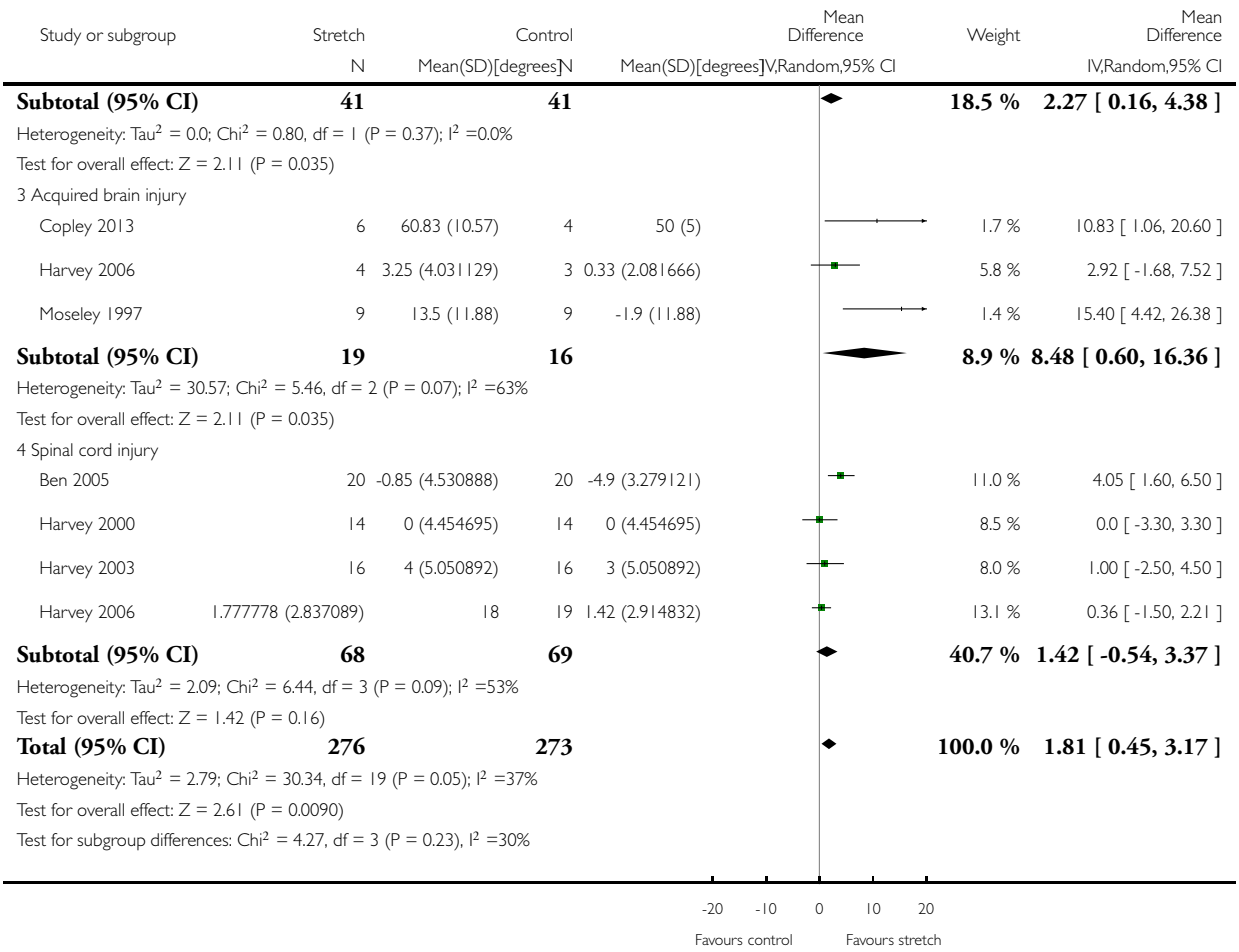

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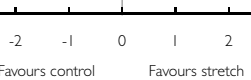
Analysis 1.2. Comparison 1 Joint mobility - short-term effects following stretch, Outcome 2 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 1 Joint mobility - short-term effects following stretch

Outcome: 2 Non-neurological conditions

Study or subgroup	Stretch N	Stretch Mean(SD)[deg or mm]	Control N	Control Mean(SD)[deg or mm]	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Frail elderly							
Fox 2000	12	1.64 (3.274401)	12	0 (3.274401)		3.5 %	0.48 [-0.33, 1.30]
Steffen 1995	1.166667 (10.15324)		18	18	0.44 (11.1367)	5.0 %	0.07 [-0.59, 0.72]
Subtotal (95% CI)	**30**		**30**			**8.5 %**	**0.23 [-0.28, 0.74]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.61$, df = 1 (P = 0.43); $I^2 = 0.0\%$							
Test for overall effect: Z = 0.88 (P = 0.38)							
2 Ankle fracture							
Moseley 2005	46	0 (5.383214)	47	0.3 (5.441412)		9.5 %	-0.05 [-0.46, 0.35]
Subtotal (95% CI)	**46**		**47**			**9.5 %**	**-0.05 [-0.46, 0.35]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.26 (P = 0.79)							
3 Anklylosing spondylitis							
Bulstrode 1987	27	2.4 (4.4)	12	-0.4 (4.3)		4.5 %	0.63 [-0.07, 1.32]
Subtotal (95% CI)	**27**		**12**			**4.5 %**	**0.63 [-0.07, 1.32]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.77 (P = 0.077)							
4 Oral submucous fibrosis							
Cox 2009 (1)	16	7.75 (8.858141)	8	1.38 (1.92261)		3.0 %	0.83 [-0.05, 1.72]
Subtotal (95% CI)	**16**		**8**			**3.0 %**	**0.83 [-0.05, 1.72]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.84 (P = 0.066)							
5 Post-radiation therapy to breast							
Lee 2007	29	28.4 (9.2)	27	27.9 (9.3)		6.9 %	0.05 [-0.47, 0.58]
Subtotal (95% CI)	**29**		**27**			**6.9 %**	**0.05 [-0.47, 0.58]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.20 (P = 0.84)							
6 Post-radiation therapy to jaw							
Buchbinder 1993 (2)	13.55556 (6.635343)		9	5	4.4 (2.302173)	1.6 %	1.54 [0.25, 2.82]
Subtotal (95% CI)	**9**		**5**			**1.6 %**	**1.54 [0.25, 2.82]**
Heterogeneity: not applicable							



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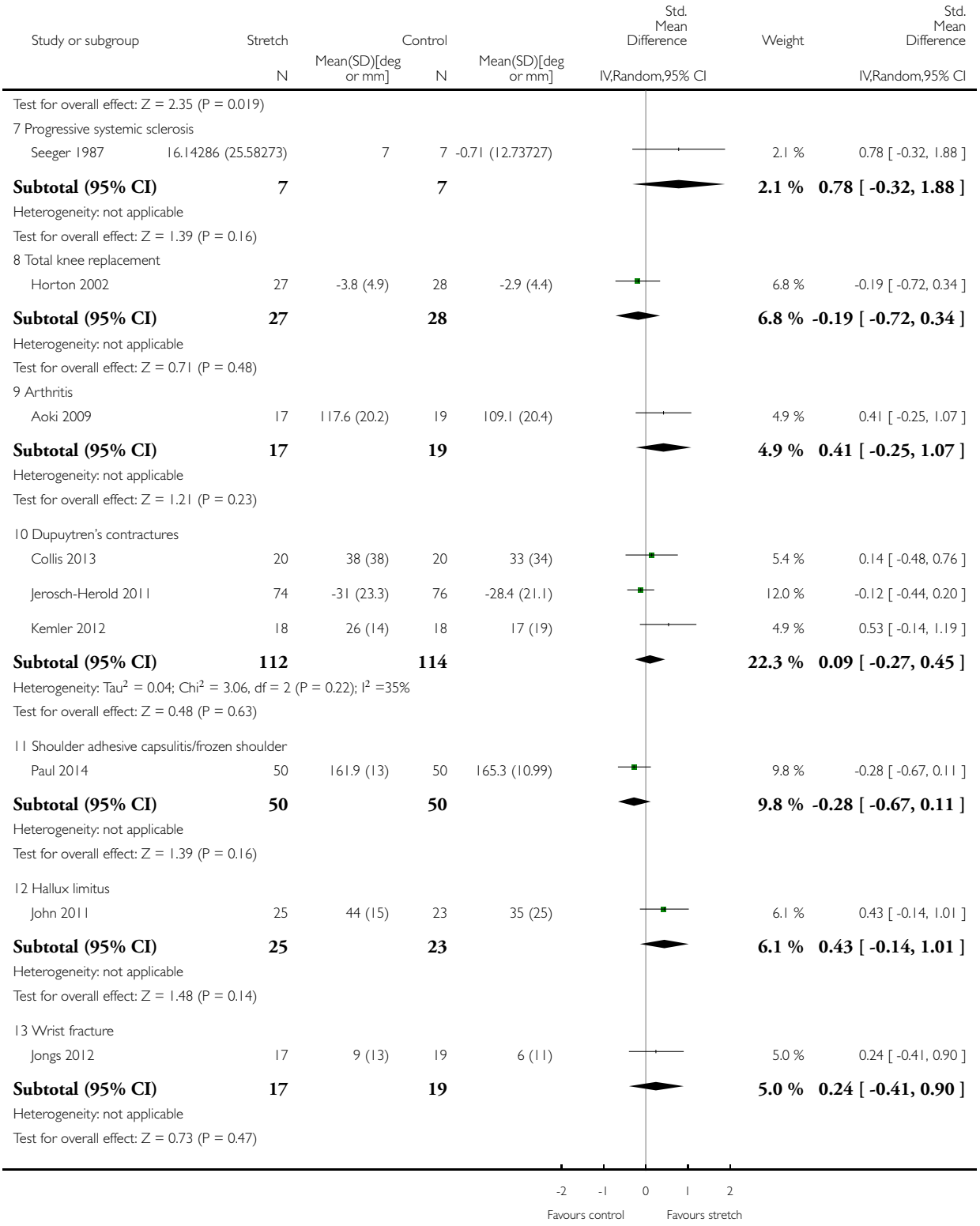

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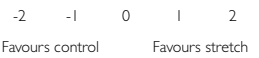
Study or subgroup	Stretch N	Stretch Mean(SD)[deg or mm]	Control N	Control Mean(SD)[deg or mm]	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
14 Burns							
Jang 2015	11	94.8 (22)	13	87 (18.4)		3.5 %	0.37 [-0.44, 1.19]
Kolmus 2012	19	151.5 (7.77)	21	151.5 (7.77)		5.4 %	0.0 [-0.62, 0.62]
Subtotal (95% CI)	**30**		**34**			**9.0 %**	**0.14 [-0.35, 0.63]**
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.52, df = 1 (P = 0.47); I^2 =0.0%							
Test for overall effect: Z = 0.55 (P = 0.58)							
Total (95% CI)	**442**		**423**			**100.0 %**	**0.16 [0.00, 0.33]**
Heterogeneity: Tau^2 = 0.03; Chi^2 = 23.49, df = 17 (P = 0.13); I^2 =28%							
Test for overall effect: Z = 1.92 (P = 0.055)							
Test for subgroup differences: Chi^2 = 18.86, df = 13 (P = 0.13), I^2 =31%							



(1) Data from Cox 2009 are expressed in millimetres

(2) Data from Buchbinder 1993 are expressed in millimetres

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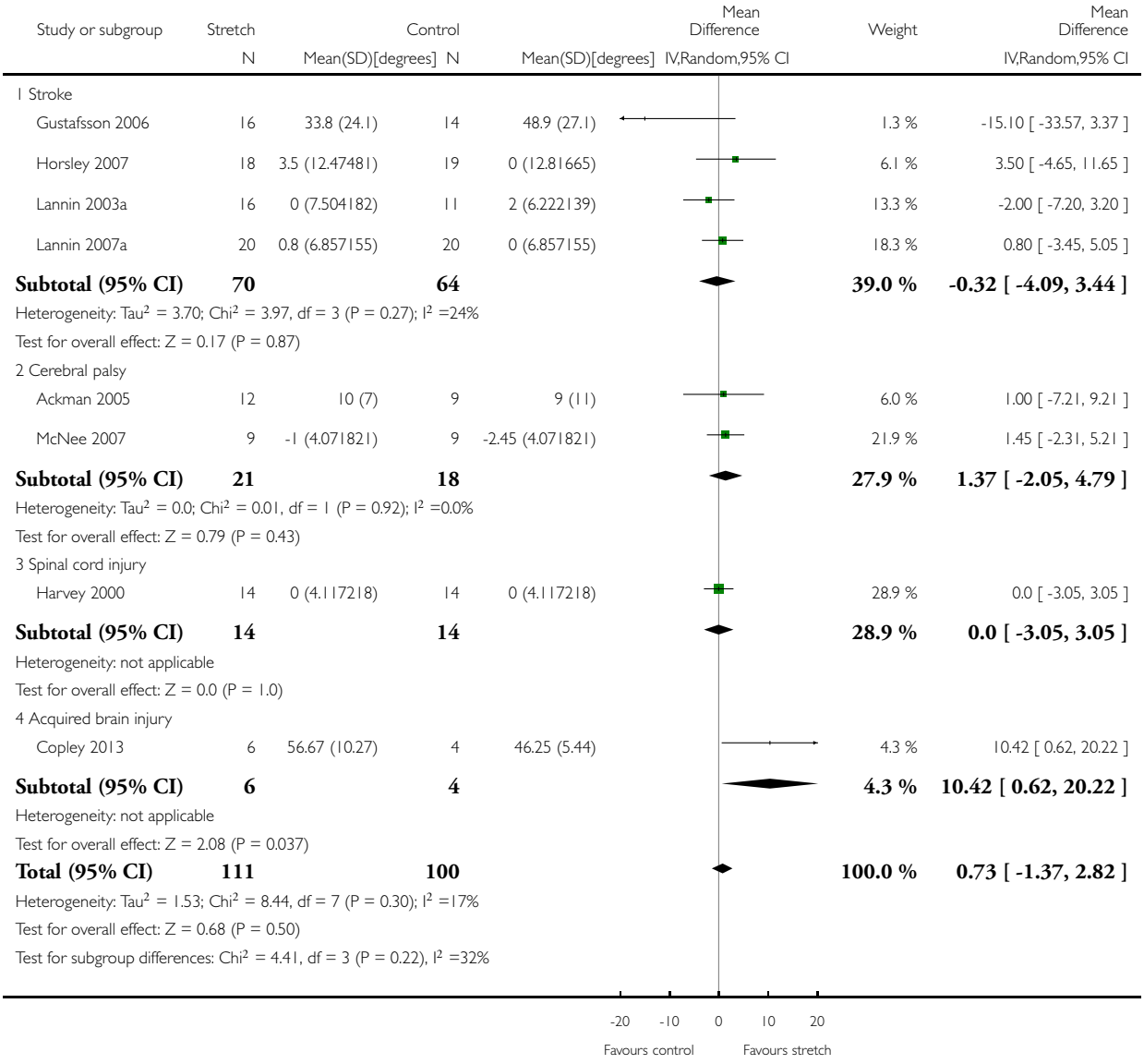
Analysis 2.1. Comparison 2 Joint mobility - long-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 2 Joint mobility - long-term effects following stretch

Outcome: 1 Neurological conditions



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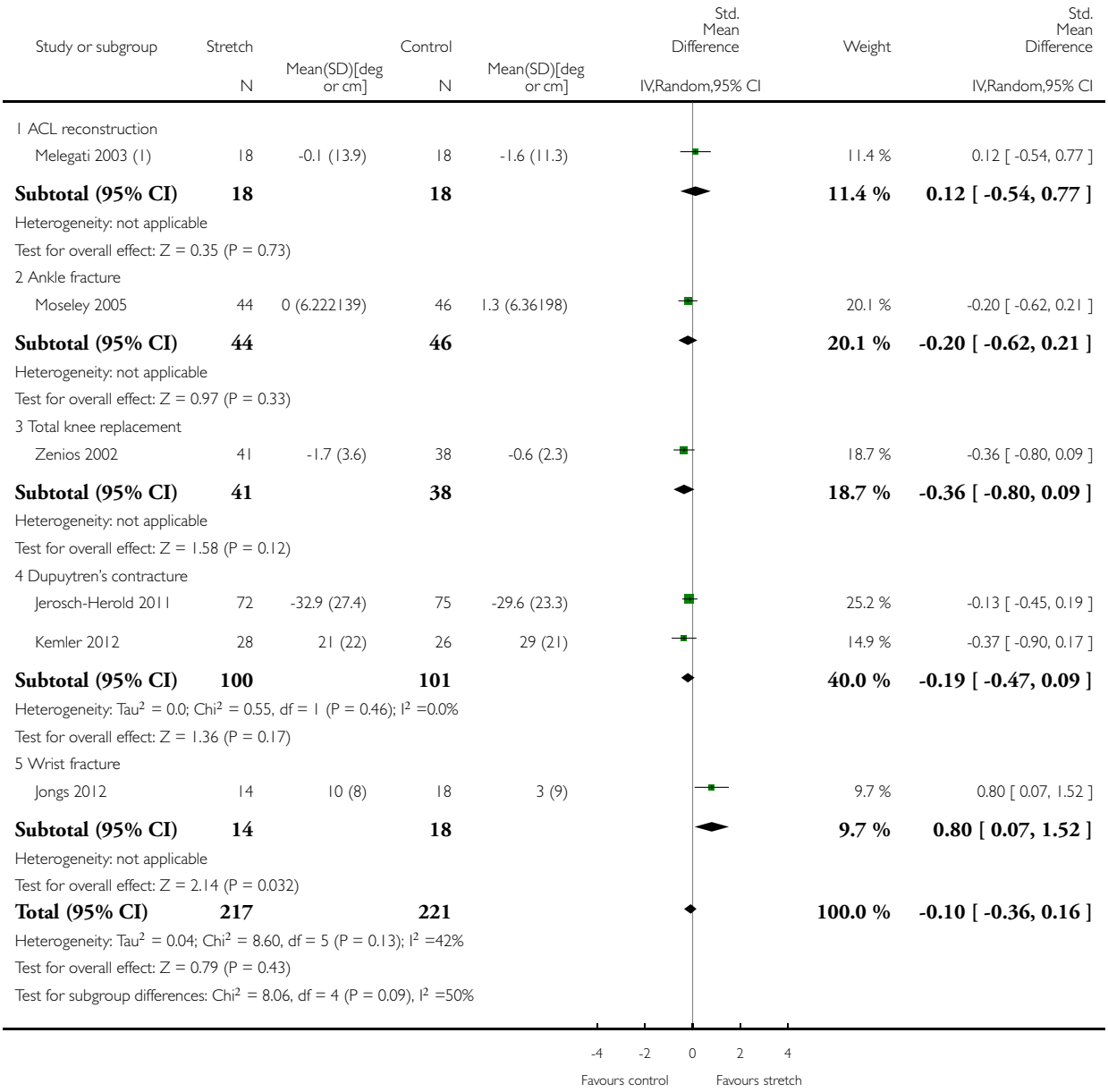
Analysis 2.2. Comparison 2 Joint mobility - long-term effects following stretch, Outcome 2 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 2 Joint mobility - long-term effects following stretch

Outcome: 2 Non-neurological conditions



(1) Data from Melegati 2003 are expressed in centimetres

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Analysis 3.1. Comparison 3 Quality of life - short-term effects following stretch, Outcome 1 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 3 Quality of life - short-term effects following stretch

Outcome: 1 Non-neurological conditions

Study or subgroup	Stretch N	Mean(SD)[points]	Control N	Mean(SD)[points]	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Post-radiation therapy to breast							
Lee 2007	28	-77.07 (16.551)	29	-79.55 (17.16)		59.7 %	0.15 [-0.37, 0.67]
Subtotal (95% CI)	**28**		**29**			**59.7 %**	**0.15 [-0.37, 0.67]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.55 (P = 0.58)							
2 Burns							
Kolmus 2012	19	132.06 (7.1)	21	128 (7.32)		40.3 %	0.55 [-0.08, 1.18]
Subtotal (95% CI)	**19**		**21**			**40.3 %**	**0.55 [-0.08, 1.18]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.71 (P = 0.088)							
Total (95% CI)	**47**		**50**			**100.0 %**	**0.31 [-0.09, 0.71]**
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.94, df = 1 (P = 0.33); I^2 =0.0%							
Test for overall effect: Z = 1.51 (P = 0.13)							
Test for subgroup differences: Chi^2 = 0.94, df = 1 (P = 0.33), I^2 =0.0%							

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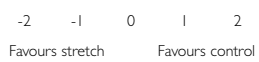
Analysis 4.1. Comparison 4 Pain - short-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 4 Pain - short-term effects following stretch

Outcome: 1 Neurological conditions

Study or subgroup	Stretch N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Stroke							
Gustafsson 2006	16	4 (7.9)	14	1.6 (3.3)		17.2 %	0.38 [-0.35, 1.10]
Horsley 2007	20	0.2 (1.855465)	18	0 (1.760249)		22.2 %	0.11 [-0.53, 0.75]
Lannin 2003a	14	0.2 (3.374769)	11	0 (2.991413)		14.5 %	0.06 [-0.73, 0.85]
Lannin 2007a	21	7.5 (11.9037)	21	0 (11.9037)		23.4 %	0.62 [0.00, 1.24]
Subtotal (95% CI)	**71**		**64**			**77.3 %**	**0.31 [-0.03, 0.66]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 1.75$, df = 3 (P = 0.63); $I^2 = 0.0\%$							
Test for overall effect: Z = 1.80 (P = 0.072)							
2 Spinal cord injury							
Crowe 2000	18	1.7 (2.3)	21	2.1 (2)		22.7 %	-0.18 [-0.81, 0.45]
Subtotal (95% CI)	**18**		**21**			**22.7 %**	**-0.18 [-0.81, 0.45]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.57 (P = 0.57)							
Total (95% CI)	**89**		**85**			**100.0 %**	**0.20 [-0.10, 0.50]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 3.59$, df = 4 (P = 0.46); $I^2 = 0.0\%$							
Test for overall effect: Z = 1.31 (P = 0.19)							
Test for subgroup differences: $Chi^2 = 1.84$, df = 1 (P = 0.18), $I^2 = 46\%$							



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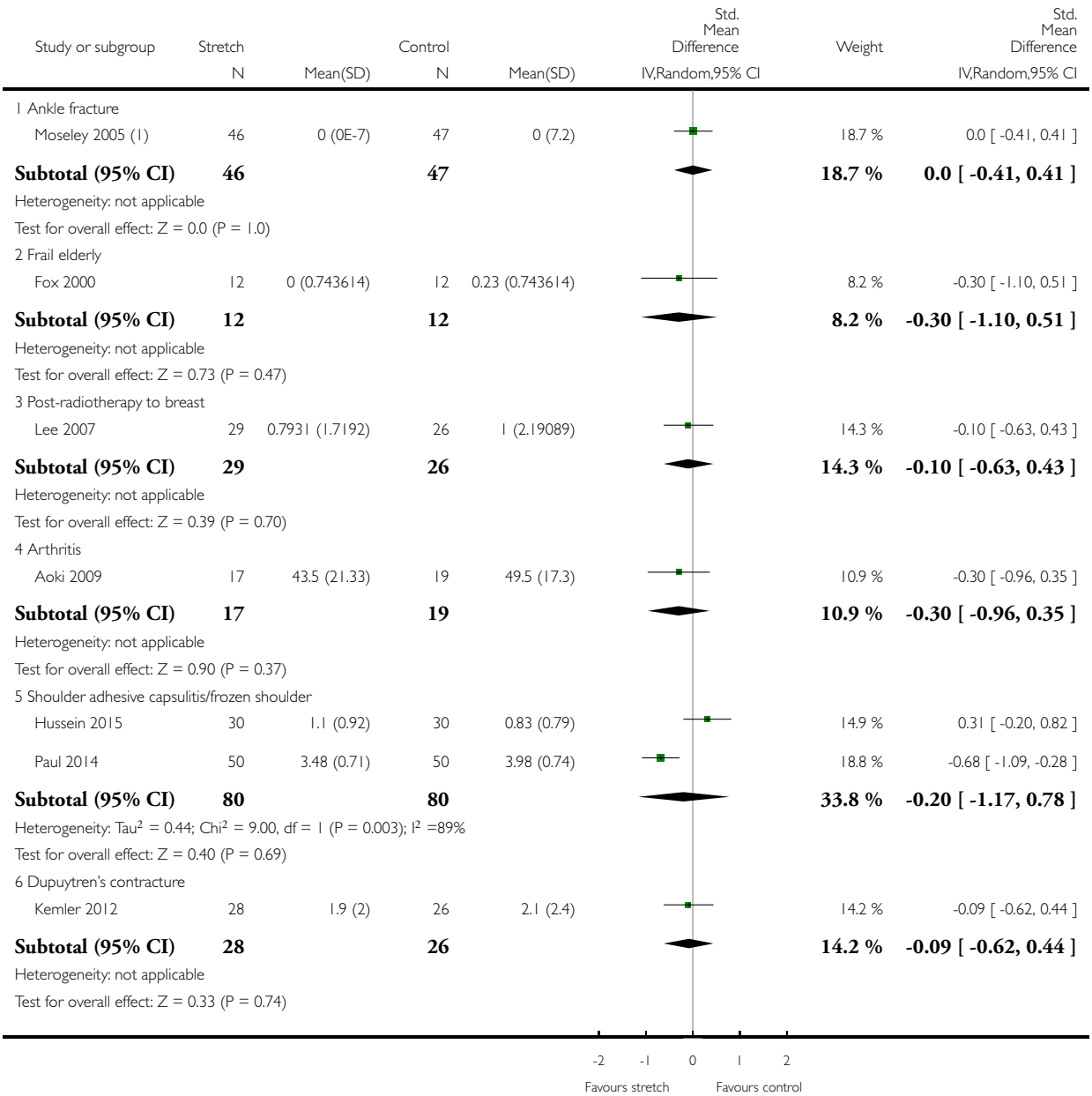
Analysis 4.2. Comparison 4 Pain - short-term effects following stretch, Outcome 2 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 4 Pain - short-term effects following stretch

Outcome: 2 Non-neurological conditions



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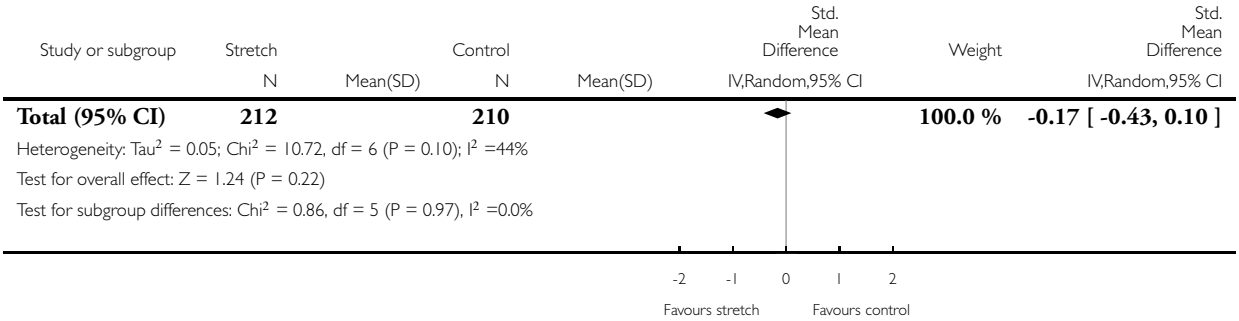


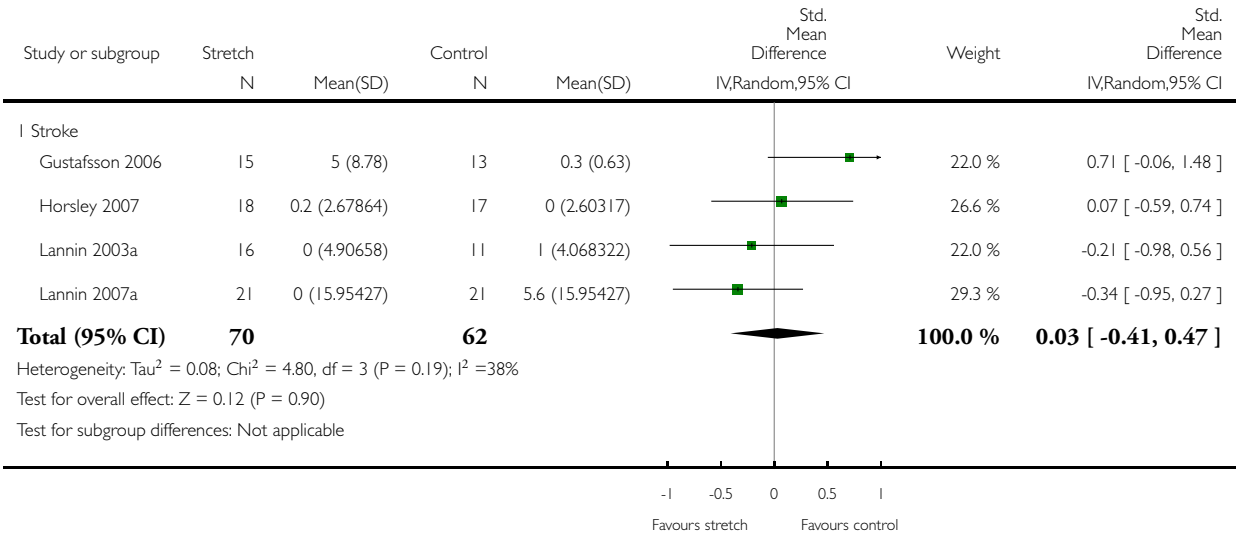
(1) Actual value of experimental SD for Moseley 2005 was zero. The value 0.00000001 was added so that meta-analysis could be conducted

Analysis 5.1. Comparison 5 Pain - long-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 5 Pain - long-term effects following stretch

Outcome: 1 Neurological conditions



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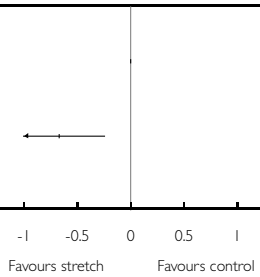
Analysis 5.2. Comparison 5 Pain - long-term effects following stretch, Outcome 2 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 5 Pain - long-term effects following stretch

Outcome: 2 Non-neurological conditions

Study or subgroup	Stretch N	Mean(SD)[mm]	Control N	Mean(SD)[mm]	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
1 Ankle fracture						
Moseley 2005	44	0 (0E-7)	46	0 (0E-7)		0.0 [0.00, 0.00]
2 Shoulder adhesive capsulitis						
Hussein 2015	30	0.8 (0.92)	30	1.47 (0.78)		-0.67 [-1.10, -0.24]



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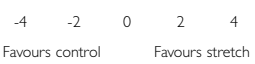
Analysis 6.1. Comparison 6 Activity limitations - short-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 6 Activity limitations - short-term effects following stretch

Outcome: 1 Neurological conditions

Study or subgroup	Stretch N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Stroke							
Ada 2005	15	1 (1.6)	16	0 (0.8)		13.1 %	0.78 [0.04, 1.51]
Gustafsson 2006	17	71 (28.4)	15	79.3 (27.3)		14.0 %	-0.29 [-0.99, 0.41]
Horsley 2007	20	1.7 (3.388241)	20	0 (3.388241)		15.9 %	0.49 [-0.14, 1.12]
Lannin 2003a	14	0 (3.50976)	11	0.1 (3.111069)		11.9 %	-0.03 [-0.82, 0.76]
Lannin 2007a	21	0 (9.919754)	21	-3.4 (9.919754)		16.5 %	0.34 [-0.27, 0.95]
Subtotal (95% CI)	**87**		**83**			**71.5 %**	**0.27 [-0.09, 0.63]**
Heterogeneity: Tau^2 = 0.04; Chi^2 = 5.38, df = 4 (P = 0.25); I^2 =26%							
Test for overall effect: Z = 1.49 (P = 0.14)							
2 Cerebral palsy							
Law 1991	19	35.4 (13.9)	18	28.1 (18.4)		15.2 %	0.44 [-0.21, 1.09]
Subtotal (95% CI)	**19**		**18**			**15.2 %**	**0.44 [-0.21, 1.09]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.32 (P = 0.19)							
3 Charcot-Marie-Tooth disease							
Rose 2010	15	-0.06 (0.12)	15	0 (0.12)		13.3 %	-0.49 [-1.21, 0.24]
Subtotal (95% CI)	**15**		**15**			**13.3 %**	**-0.49 [-1.21, 0.24]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.31 (P = 0.19)							
Total (95% CI)	**121**		**116**			**100.0 %**	**0.19 [-0.13, 0.52]**
Heterogeneity: Tau^2 = 0.07; Chi^2 = 9.54, df = 6 (P = 0.15); I^2 =37%							
Test for overall effect: Z = 1.16 (P = 0.25)							
Test for subgroup differences: Chi^2 = 4.08, df = 2 (P = 0.13), I^2 =51%							



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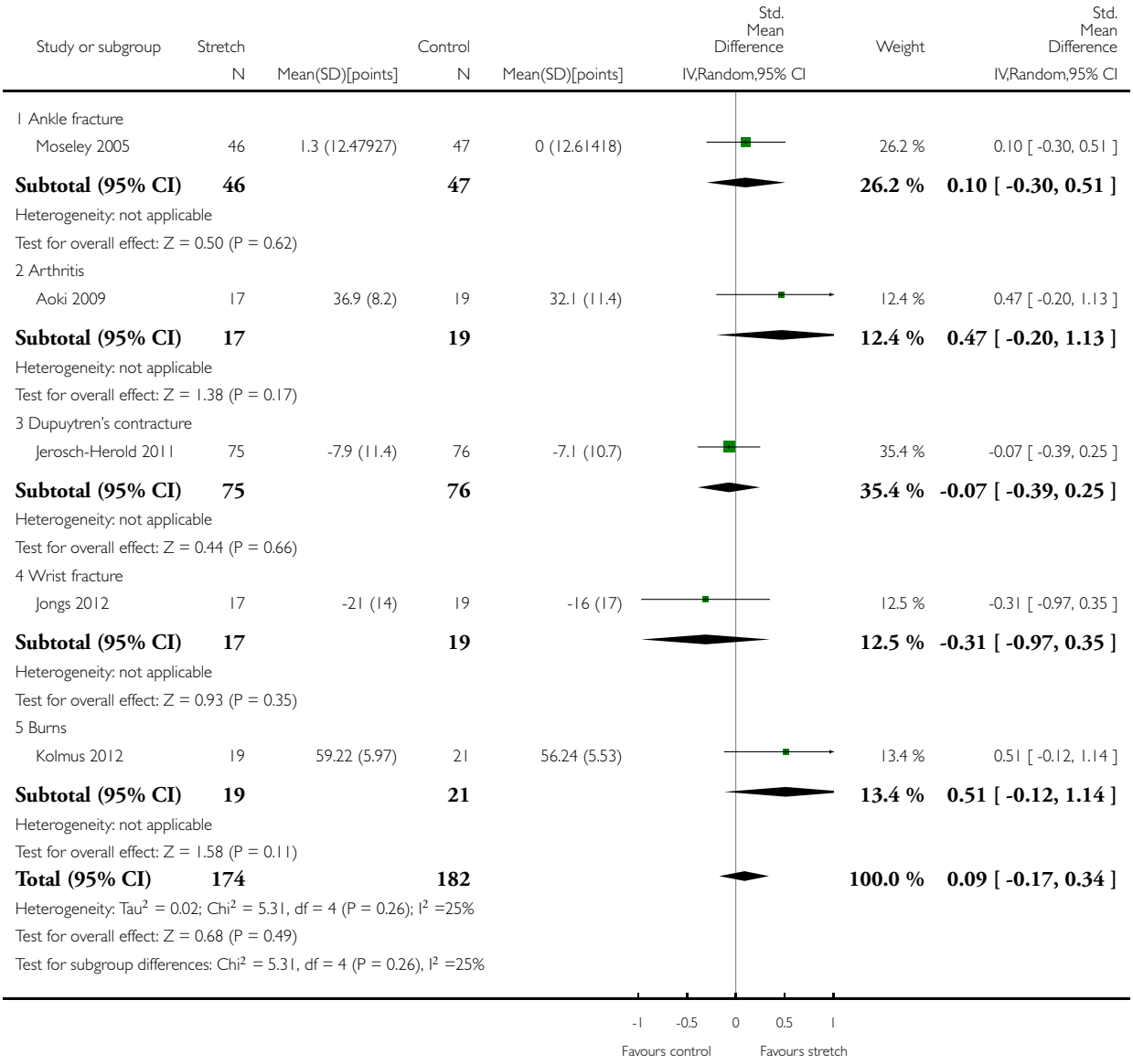
Analysis 6.2. Comparison 6 Activity limitations - short-term effects following stretch, Outcome 2 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 6 Activity limitations - short-term effects following stretch

Outcome: 2 Non-neurological conditions



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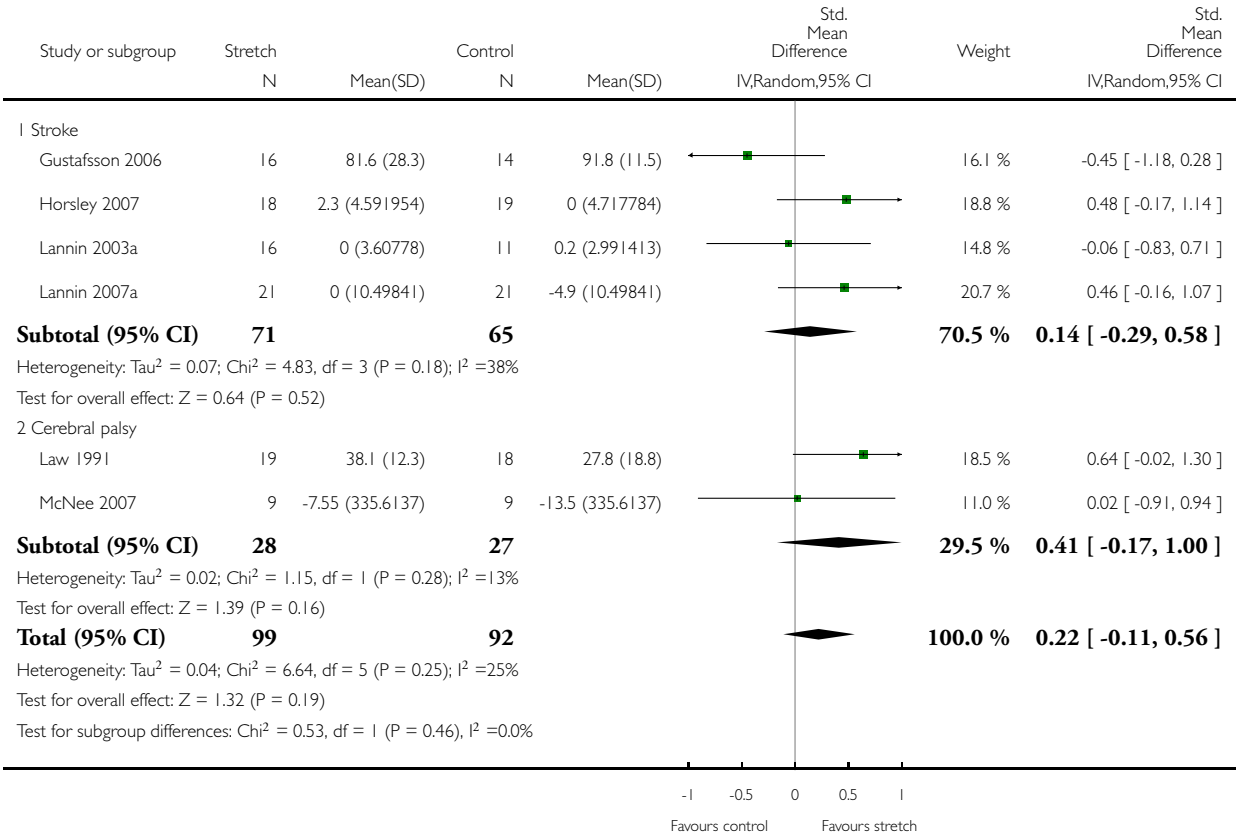
Analysis 7.1. Comparison 7 Activity limitations - long-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 7 Activity limitations - long-term effects following stretch

Outcome: 1 Neurological conditions



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Analysis 7.2. Comparison 7 Activity limitations - long-term effects following stretch, Outcome 2 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 7 Activity limitations - long-term effects following stretch

Outcome: 2 Non-neurological conditions

Study or subgroup	Stretch N	Mean(SD)[points]	Control N	Mean(SD)[points]	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Ankle fracture							
Moseley 2005	44	0 (13.52119)	46	0.9 (13.82507)		33.7 %	-0.07 [-0.48, 0.35]
Subtotal (95% CI)	**44**		**46**			**33.7 %**	**-0.07 [-0.48, 0.35]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.31 (P = 0.76)							
2 Dupuytren's contracture							
Jerosch-Herold 2011	71	-7 (14.6)	75	-6 (9.2)		54.6 %	-0.08 [-0.41, 0.24]
Subtotal (95% CI)	**71**		**75**			**54.6 %**	**-0.08 [-0.41, 0.24]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.50 (P = 0.62)							
3 Wrist fracture							
Jongs 2012	14	-24 (17)	18	-21 (20)		11.8 %	-0.16 [-0.86, 0.54]
Subtotal (95% CI)	**14**		**18**			**11.8 %**	**-0.16 [-0.86, 0.54]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.44 (P = 0.66)							
Total (95% CI)	**129**		**139**			**100.0 %**	**-0.09 [-0.32, 0.15]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.05$, df = 2 (P = 0.98); $I^2 = 0.0\%$							
Test for overall effect: Z = 0.69 (P = 0.49)							
Test for subgroup differences: $Chi^2 = 0.05$, df = 2 (P = 0.98), $I^2 = 0.0\%$							

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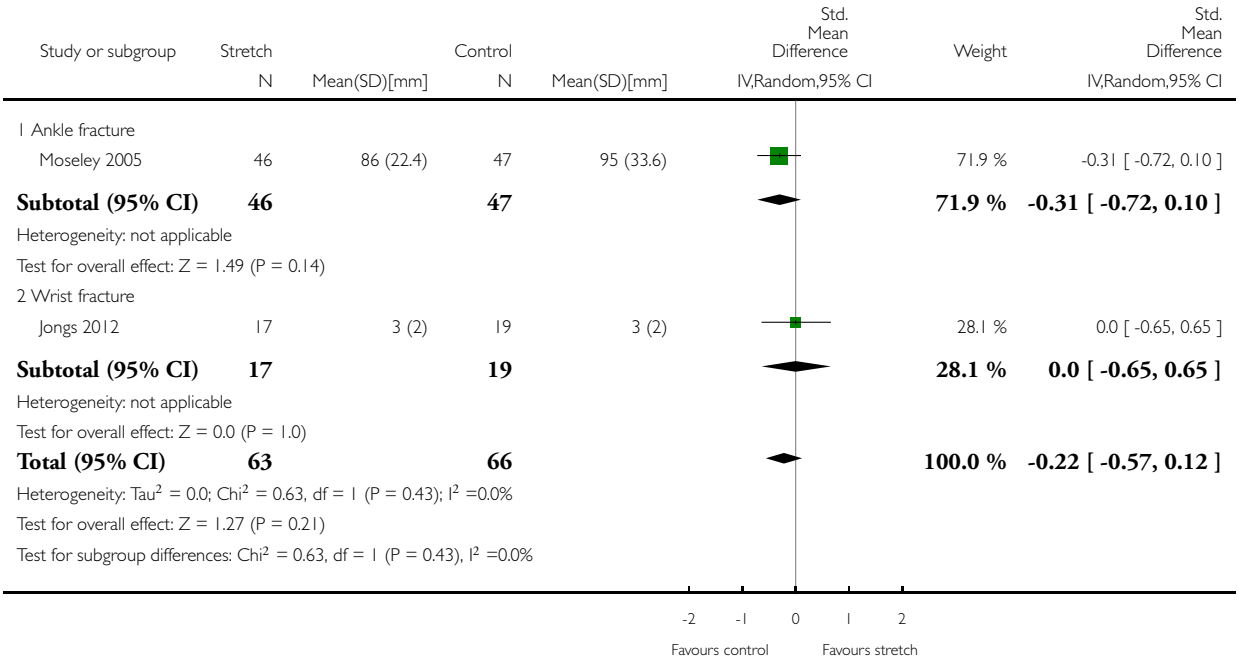
Analysis 8.1. Comparison 8 Participation restrictions - short-term effects following stretch, Outcome 1 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 8 Participation restrictions - short-term effects following stretch

Outcome: 1 Non-neurological conditions



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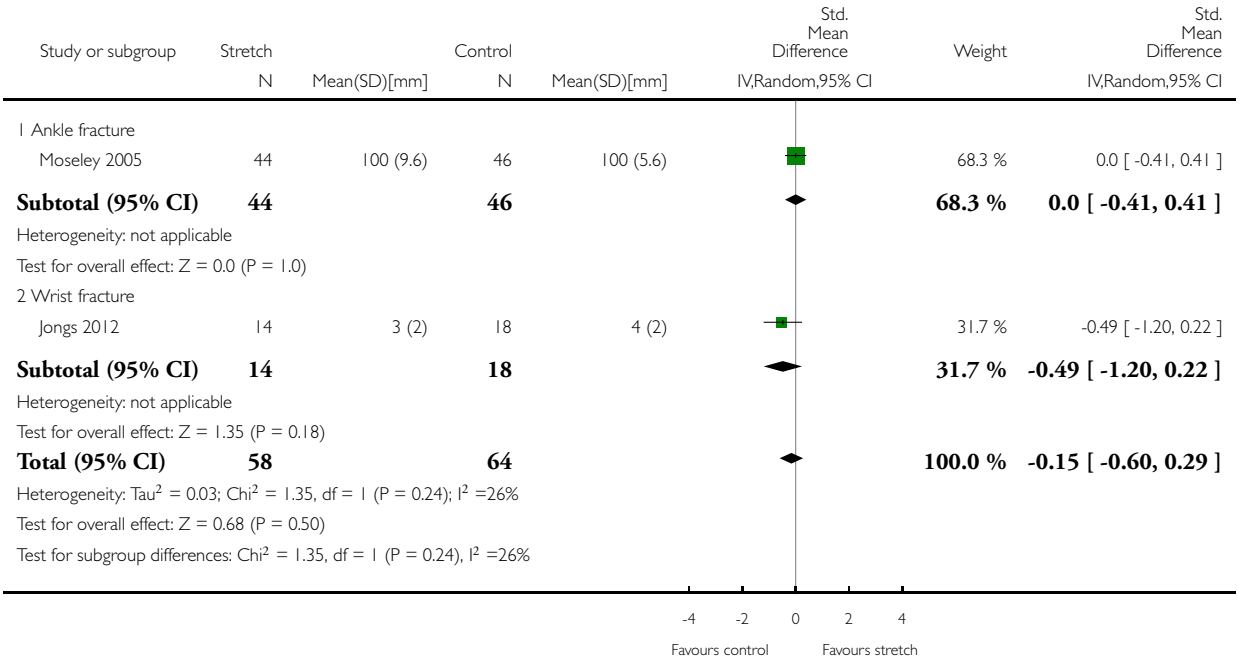
Analysis 9.1. Comparison 9 Participation restrictions - long-term effects following stretch, Outcome 1 Non-neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 9 Participation restrictions - long-term effects following stretch

Outcome: 1 Non-neurological conditions



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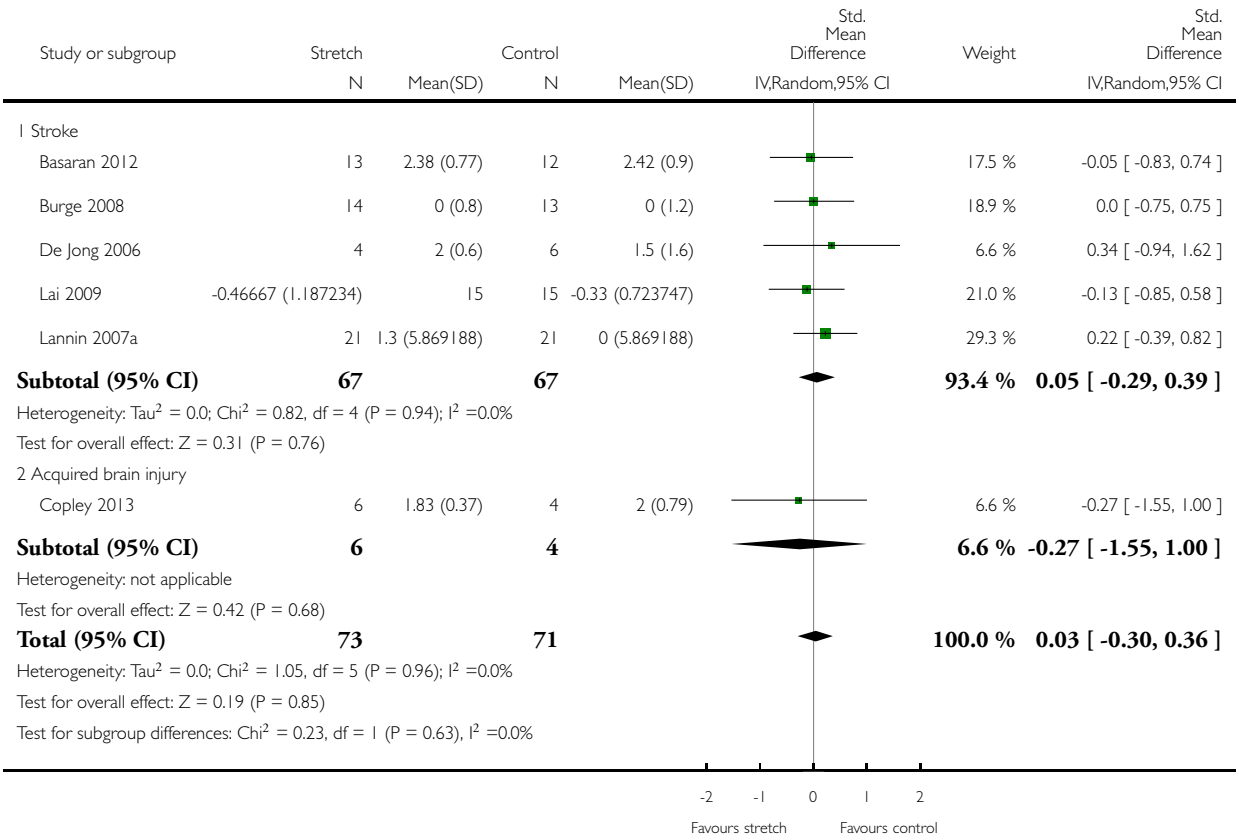
Analysis 10.1. Comparison 10 Spasticity - short-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 10 Spasticity - short-term effects following stretch

Outcome: 1 Neurological conditions



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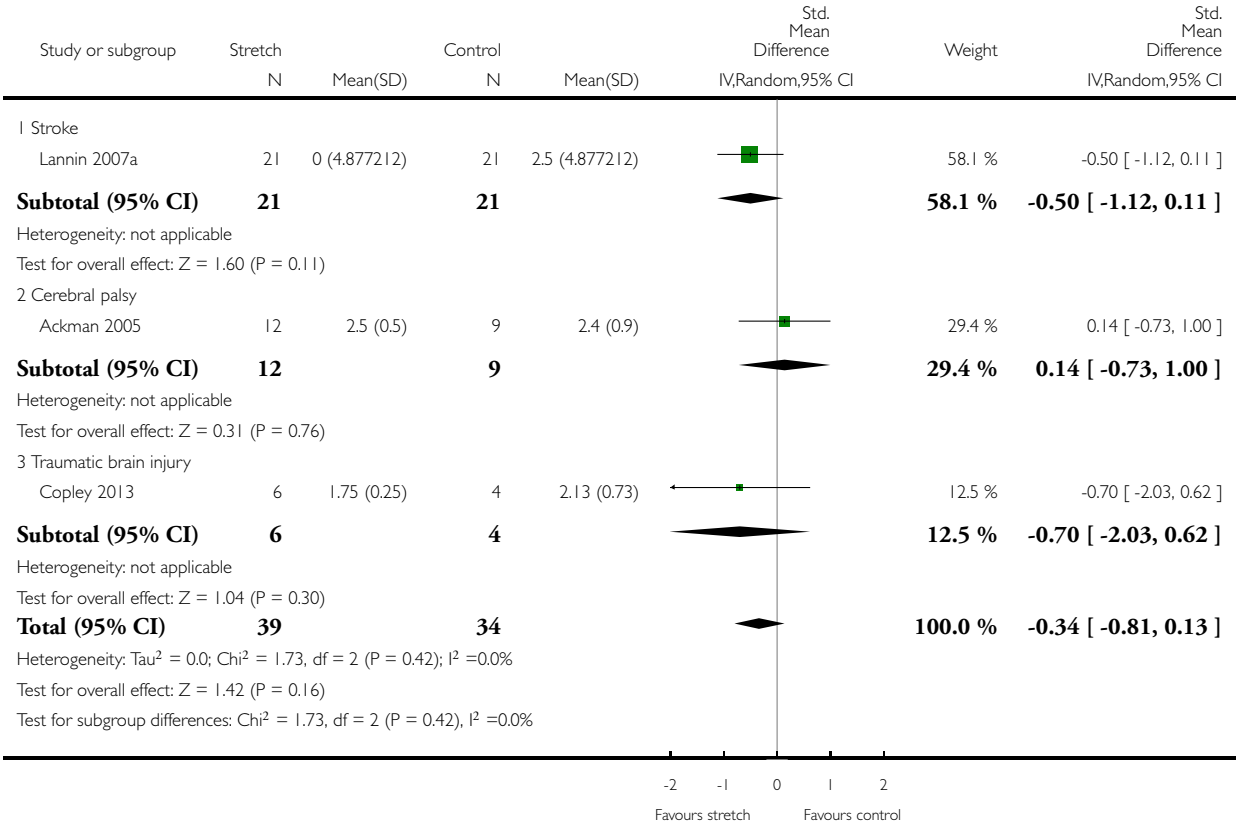
Analysis 11.1. Comparison 11 Spasticity - long-term effects following stretch, Outcome 1 Neurological conditions.

Review: Stretch for the treatment and prevention of contractures

Comparison: 11 Spasticity - long-term effects following stretch

Outcome: 1 Neurological conditions



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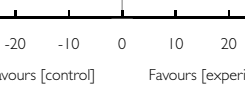
Analysis 12.1. Comparison 12 Joint mobility - subgroup analyses, Outcome 1 Types of stretch intervention.

Review: Stretch for the treatment and prevention of contractures

Comparison: 12 Joint mobility - subgroup analyses

Outcome: 1 Types of stretch intervention

Study or subgroup	Stretch N	Stretch Mean(SD)	Control N	Control Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Cast							
Ackman 2005	12	10 (7)	9	9 (11)		1.4 %	1.00 [-7.21, 9.21]
McNee 2007	9	-1 (4.071821)	9	-2.45 (4.071821)		4.3 %	1.45 [-2.31, 5.21]
Moseley 1997	9	13.5 (11.87939)	9	-1.9 (11.87939)		0.8 %	15.40 [4.42, 26.38]
Subtotal (95% CI)	**30**		**27**			**6.5 %**	**4.59 [-2.60, 11.78]**
Heterogeneity: Tau^2 = 25.89; Chi^2 = 5.73, df = 2 (P = 0.06); I^2 =65%							
Test for overall effect: Z = 1.25 (P = 0.21)							
2 Splint							
Basaran 2012	13	52.31 (19.11)	12	52.5 (19.48)		0.4 %	-0.19 [-15.34, 14.96]
Collis 2013	20	38 (38)	20	33 (34)		0.2 %	5.00 [-17.35, 27.35]
Copley 2013	6	56.67 (10.27)	4	46.25 (5.44)		1.0 %	10.42 [0.62, 20.22]
Harvey 2006	1.758621 (2.914273)	29	29	1.41 (2.914273)		8.3 %	0.34 [-1.16, 1.84]
Horton 2002	27	-3.8 (4.9)	28	-2.9 (4.4)		6.4 %	-0.90 [-3.36, 1.56]
Jerosch-Herold 2011	72	-32.9 (27.4)	75	-29.6 (23.3)		1.4 %	-3.30 [-11.54, 4.94]
John 2011	25	44 (15)	23	35 (25)		0.7 %	9.00 [-2.79, 20.79]
Jongs 2012	14	10 (8)	18	3 (9)		2.4 %	7.00 [1.10, 12.90]
Kemler 2012	28	21 (22)	26	29 (21)		0.8 %	-8.00 [-19.47, 3.47]
Kolmus 2012	19	151.5 (7.77)	21	151.5 (7.77)		3.2 %	0.0 [-4.82, 4.82]
Lai 2009	23.66667 (28.27333)	15	15	14.4 (26.8775)		0.3 %	9.27 [-10.47, 29.01]
Lannin 2003a	16	0 (7.504182)	11	2 (6.222139)		2.8 %	-2.00 [-7.20, 3.20]
Lannin 2007a	20	0.8 (6.857155)	20	0 (6.857155)		3.7 %	0.80 [-3.45, 5.05]
Refshauge 2006	26	1 (6.438649)	26	0 (6.438649)		4.7 %	1.00 [-2.50, 4.50]
Seeger 1987	16.14286 (25.58273)	7	7	-0.71 (12.73727)		0.2 %	16.86 [-4.31, 38.03]
Steffen 1995	1.166667 (10.15324)	18	18	0.44 (11.1367)		1.8 %	0.72 [-6.24, 7.68]
Zenios 2002	41	-1.7 (3.6)	38	-0.6 (2.3)		8.7 %	-1.10 [-2.42, 0.22]
Subtotal (95% CI)	**396**		**391**			**47.0 %**	**0.27 [-1.02, 1.55]**
Heterogeneity: Tau^2 = 1.45; Chi^2 = 22.25, df = 16 (P = 0.14); I^2 =28%							



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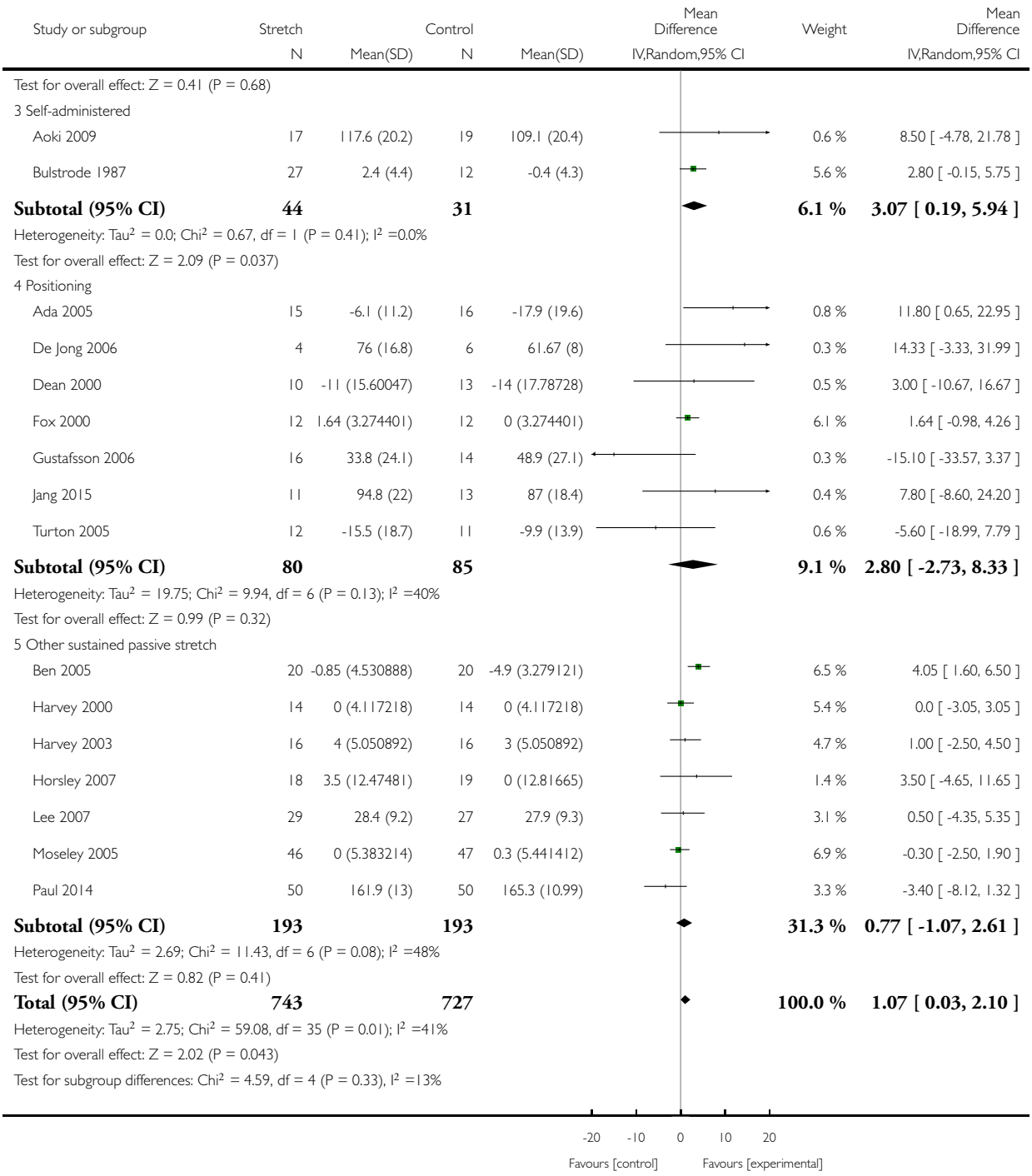

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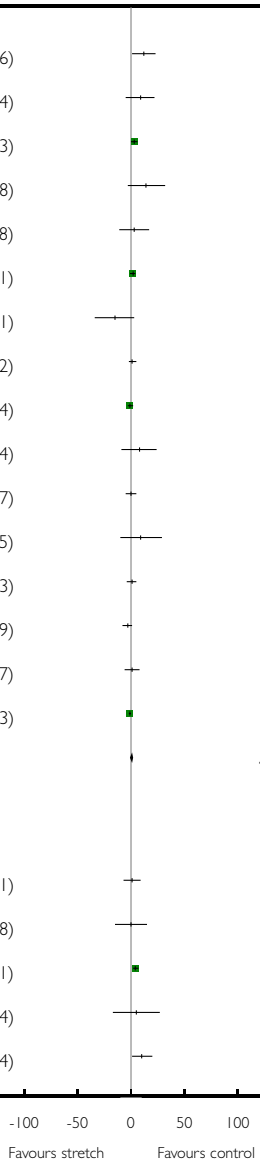
Analysis 12.2. Comparison 12 Joint mobility - subgroup analyses, Outcome 2 Large versus small joints.

Review: Stretch for the treatment and prevention of contractures

Comparison: 12 Joint mobility - subgroup analyses

Outcome: 2 Large versus small joints

Study or subgroup	Stretch N	Stretch Mean(SD)	Control N	Control Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Large joints							
Ada 2005	15	-6.1 (11.2)	16	-17.9 (19.6)		0.8 %	11.80 [0.65, 22.95]
Aoki 2009	17	117.6 (20.2)	19	109.1 (20.4)		0.6 %	8.50 [-4.78, 21.78]
Bulstrode 1987	27	2.4 (4.4)	12	-0.4 (4.3)		5.6 %	2.80 [-0.15, 5.75]
De Jong 2006	4	76 (16.8)	6	61.67 (8)		0.3 %	14.33 [-3.33, 31.99]
Dean 2000	10	-11 (15.60047)	13	-14 (17.78728)		0.6 %	3.00 [-10.67, 16.67]
Fox 2000	12	1.64 (3.274401)	12	0 (3.274401)		6.1 %	1.64 [-0.98, 4.26]
Gustafsson 2006	16	33.8 (24.1)	14	48.9 (27.1)		0.3 %	-15.10 [-33.57, 3.37]
Harvey 2003	16	4 (5.050892)	16	3 (5.050892)		4.7 %	1.00 [-2.50, 4.50]
Horton 2002	27	-3.8 (4.9)	28	-2.9 (4.4)		6.4 %	-0.90 [-3.36, 1.56]
Jang 2015	11	94.8 (22)	13	87 (18.4)		0.4 %	7.80 [-8.60, 24.20]
Kolmus 2012	19	151.5 (7.77)	21	151.5 (7.77)		3.2 %	0.0 [-4.82, 4.82]
Lai 2009	23.6666667 (28.27333)		15	14.4 (26.8775)		0.3 %	9.27 [-10.47, 29.01]
Lee 2007	29	28.4 (9.2)	27	27.9 (9.3)		3.2 %	0.50 [-4.35, 5.35]
Paul 2014	50	161.9 (13)	50	165.3 (10.99)		3.3 %	-3.40 [-8.12, 1.32]
Steffen 1995	1.1666667 (10.15324)		18	18	0.44 (11.1367)	1.9 %	0.72 [-6.24, 7.68]
Zenios 2002	41	-1.7 (3.6)	38	-0.6 (2.3)		8.5 %	-1.10 [-2.42, 0.22]
Subtotal (95% CI)	**327**		**318**			**46.3 %**	**0.57 [-0.89, 2.03]**
Heterogeneity: Tau² = 2.32; Chi² = 23.41, df = 15 (P = 0.08); I² =36%							
Test for overall effect: Z = 0.77 (P = 0.44)							
2 Small joints							
Ackman 2005	12	10 (7)	9	9 (11)		1.4 %	1.00 [-7.21, 9.21]
Basaran 2012	13	52.31 (19.11)	12	52.5 (19.48)		0.5 %	-0.19 [-15.34, 14.96]
Ben 2005	20	-0.85 (4.530888)	20	-4.9 (3.279121)		6.4 %	4.05 [1.60, 6.50]
Collis 2013	20	38 (38)	20	33 (34)		0.2 %	5.00 [-17.35, 27.35]
Copley 2013	6	56.67 (10.27)	4	46.25 (5.44)		1.0 %	10.42 [0.62, 20.22]



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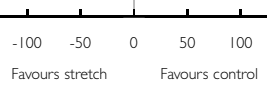
Study or subgroup	Stretch N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Harvey 2000	14	0 (4.117218)	14	0 (4.117218)		5.4 %	0.0 [-3.05, 3.05]
Harvey 2006	1.7586207 (2.914273)	29	29	1.41 (2.914273)		8.2 %	0.34 [-1.16, 1.84]
Horsley 2007	18	3.5 (12.47481)	19	0 (12.81665)		1.4 %	3.50 [-4.65, 11.65]
Jerosch-Herold 2011	72	-32.9 (27.4)	75	-29.6 (23.3)		1.4 %	-3.30 [-11.54, 4.94]
John 2011	25	44 (15)	23	35 (25)		0.7 %	9.00 [-2.79, 20.79]
Jongs 2012	14	10 (8)	18	3 (9)		2.4 %	7.00 [1.10, 12.90]
Kemler 2012	28	21 (22)	26	29 (21)		0.8 %	-8.00 [-19.47, 3.47]
Lannin 2003a	16	0 (7.504182)	11	2 (6.222139)		2.9 %	-2.00 [-7.20, 3.20]
Lannin 2007a	20	0.8 (6.857155)	20	0 (6.857155)		3.8 %	0.80 [-3.45, 5.05]
McNee 2007	9	-1 (4.071821)	9	-2.45 (4.071821)		4.4 %	1.45 [-2.31, 5.21]
Moseley 1997	9	13.5 (11.87939)	9	-1.9 (11.87939)		0.9 %	15.40 [4.42, 26.38]
Moseley 2005	44	0 (6.222139)	46	1.3 (6.36198)		6.2 %	-1.30 [-3.90, 1.30]
Refshauge 2006	26	1 (6.438649)	26	0 (6.438649)		4.7 %	1.00 [-2.50, 4.50]
Seeger 1987	16.1428571 (25.58273)	7	7	-0.71 (12.73727)		0.2 %	16.86 [-4.31, 38.03]
Turton 2005	12	-15.5 (18.7)	11	-9.9 (13.9)		0.6 %	-5.60 [-18.99, 7.79]
Subtotal (95% CI)	**414**		**408**			**53.7 %**	**1.44 [-0.11, 3.00]**
Heterogeneity: Tau^2 = 3.97; Chi^2 = 34.35, df = 19 (P = 0.02); I^2 =45%							
Test for overall effect: Z = 1.82 (P = 0.069)							
Total (95% CI)	**741**		**726**			**100.0 %**	**1.03 [-0.02, 2.09]**
Heterogeneity: Tau^2 = 2.98; Chi^2 = 60.42, df = 35 (P = 0.005); I^2 =42%							
Test for overall effect: Z = 1.91 (P = 0.056)							
Test for subgroup differences: Chi^2 = 0.64, df = 1 (P = 0.42), I^2 =0.0%							



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Analysis 12.3. Comparison 12 Joint mobility - subgroup analyses, Outcome 3 Influence of discomfort.

Review: Stretch for the treatment and prevention of contractures

Comparison: 12 Joint mobility - subgroup analyses

Outcome: 3 Influence of discomfort

Study or subgroup	Stretch N	Stretch Mean(SD)	Control N	Control Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Measurements influenced by discomfort							
Ackman 2005	12	10 (7)	9	9 (11)		1.4 %	1.00 [-7.21, 9.21]
Ada 2005	15	-6.1 (11.2)	16	-17.9 (19.6)		0.8 %	11.80 [0.65, 22.95]
Aoki 2009	17	117.6 (20.2)	19	109.1 (20.4)		0.6 %	8.50 [-4.78, 21.78]
Basaran 2012	13	52.31 (19.11)	12	52.5 (19.48)		0.5 %	-0.19 [-15.34, 14.96]
Bulstrode 1987	27	2.4 (4.4)	12	-0.4 (4.3)		5.5 %	2.80 [-0.15, 5.75]
Collis 2013	20	38 (38)	20	33 (34)		0.2 %	5.00 [-17.35, 27.35]
Copley 2013	6	56.67 (10.27)	4	46.25 (5.44)		1.1 %	10.42 [0.62, 20.22]
De Jong 2006	4	76 (16.8)	6	61.67 (8)		0.3 %	14.33 [-3.33, 31.99]
Dean 2000	10	-11 (15.60047)	13	-14 (17.78728)		0.6 %	3.00 [-10.67, 16.67]
Fox 2000	12	1.64 (3.274401)	12	0 (3.274401)		6.1 %	1.64 [-0.98, 4.26]
Gustafsson 2006	16	33.8 (24.1)	14	48.9 (27.1)		0.3 %	-15.10 [-33.57, 3.37]
Horton 2002	27	-3.8 (4.9)	28	-2.9 (4.4)		6.4 %	-0.90 [-3.36, 1.56]
Jang 2015	11	94.8 (22)	13	87 (18.4)		0.4 %	7.80 [-8.60, 24.20]
Jerosch-Herold 2011	72	-32.9 (27.4)	75	-29.6 (23.3)		1.4 %	-3.30 [-11.54, 4.94]
John 2011	25	44 (15)	23	35 (25)		0.8 %	9.00 [-2.79, 20.79]
Jongs 2012	14	10 (8)	18	3 (9)		2.4 %	7.00 [1.10, 12.90]
Kemler 2012	28	21 (22)	26	29 (21)		0.8 %	-8.00 [-19.47, 3.47]
Kolmus 2012	19	151.5 (7.77)	21	151.5 (7.77)		3.2 %	0.0 [-4.82, 4.82]
Lai 2009	23.6666667 (28.27333)		15	14.4 (26.8775)		0.3 %	9.27 [-10.47, 29.01]
Lee 2007	29	28.4 (9.2)	27	27.9 (9.3)		3.2 %	0.50 [-4.35, 5.35]
McNee 2007	9	-1 (4.071821)	9	-2.45 (4.071821)		4.4 %	1.45 [-2.31, 5.21]
Paul 2014	50	161.9 (13)	50	165.3 (10.99)		3.3 %	-3.40 [-8.12, 1.32]
Seeger 1987	16.1428571 (25.58273)		7	7 -0.71 (12.73727)		0.2 %	16.86 [-4.31, 38.03]
Turton 2005	12	-15.5 (18.7)	11	-9.9 (13.9)		0.6 %	-5.60 [-18.99, 7.79]

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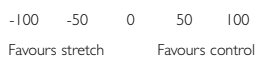
Study or subgroup	Stretch N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Zenios 2002	41	-1.7 (3.6)	38	-0.6 (2.3)		8.4 %	-1.10 [-2.42, 0.22]
Subtotal (95% CI)	**511**		**498**			**53.3 %**	**1.19 [-0.41, 2.78]**
Heterogeneity: Tau^2 = 4.38; Chi^2 = 41.25, df = 24 (P = 0.02); I^2 =42%							
Test for overall effect: Z = 1.46 (P = 0.14)							
2 Measurements not influenced by discomfort							
Ben 2005	20	-0.85 (4.530888)	20	-4.9 (3.279121)		6.4 %	4.05 [1.60, 6.50]
Harvey 2000	14	0 (4.454695)	14	0 (4.454695)		5.0 %	0.0 [-3.30, 3.30]
Harvey 2003	16	4 (5.050892)	16	3 (5.050892)		4.7 %	1.00 [-2.50, 4.50]
Harvey 2006	1.7586207 (2.914273)		29	29 1.41 (2.914273)		8.1 %	0.34 [-1.16, 1.84]
Horsley 2007	20	3.8 (10.16472)	20	0 (10.16472)		2.2 %	3.80 [-2.50, 10.10]
Lannin 2003a	16	0 (7.504182)	11	2 (6.222139)		2.9 %	-2.00 [-7.20, 3.20]
Lannin 2007a	20	0.8 (6.857155)	20	0 (6.857155)		3.8 %	0.80 [-3.45, 5.05]
Moseley 1997	9	13.5 (11.87939)	9	-1.9 (11.87939)		0.9 %	15.40 [4.42, 26.38]
Moseley 2005	44	0 (6.222139)	46	1.3 (6.36198)		6.1 %	-1.30 [-3.90, 1.30]
Refshauge 2006	26	1 (6.438649)	26	0 (6.438649)		4.7 %	1.00 [-2.50, 4.50]
Steffen 1995	1.1666667 (10.15324)		18	18 0.44 (11.1367)		1.9 %	0.72 [-6.24, 7.68]
Subtotal (95% CI)	**232**		**229**			**46.7 %**	**1.05 [-0.42, 2.52]**
Heterogeneity: Tau^2 = 2.43; Chi^2 = 18.63, df = 10 (P = 0.05); I^2 =46%							
Test for overall effect: Z = 1.40 (P = 0.16)							
Total (95% CI)	**743**		**727**			**100.0 %**	**1.07 [0.01, 2.13]**
Heterogeneity: Tau^2 = 3.05; Chi^2 = 60.94, df = 35 (P = 0.004); I^2 =43%							
Test for overall effect: Z = 1.97 (P = 0.049)							
Test for subgroup differences: Chi^2 = 0.02, df = 1 (P = 0.90), I^2 =0.0%							



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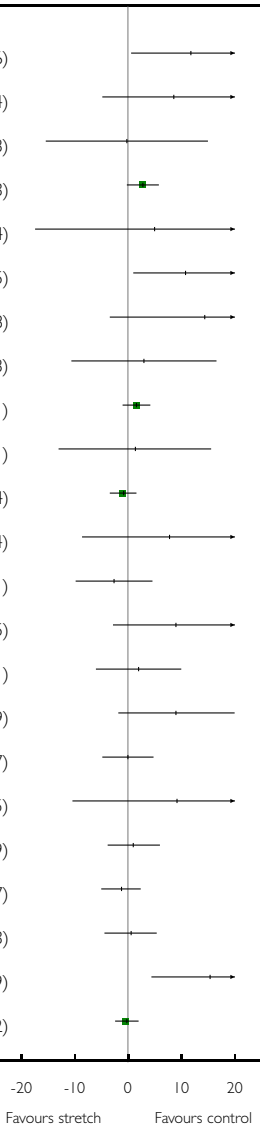
Analysis 12.4. Comparison 12 Joint mobility - subgroup analyses, Outcome 4 Joint mobility measured less than one day versus more than one day.

Review: Stretch for the treatment and prevention of contractures

Comparison: 12 Joint mobility - subgroup analyses

Outcome: 4 Joint mobility measured less than one day versus more than one day

Study or subgroup	Stretch N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Less than one day							
Ada 2005	15	-6.1 (11.2)	16	-17.9 (19.6)		0.4 %	11.80 [0.65, 22.95]
Aoki 2009	17	117.6 (20.2)	19	109.1 (20.4)		0.3 %	8.50 [-4.78, 21.78]
Basaran 2012	13	52.31 (19.11)	12	52.5 (19.48)		0.2 %	-0.19 [-15.34, 14.96]
Bulstrode 1987	27	2.4 (4.4)	12	-0.4 (4.3)		5.2 %	2.80 [-0.15, 5.75]
Collis 2013	20	38 (38)	20	33 (34)		0.1 %	5.00 [-17.35, 27.35]
Copley 2013	6	60.83 (10.57)	4	50 (5)		0.5 %	10.83 [1.06, 20.60]
De Jong 2006	4	76 (16.8)	6	61.67 (8)		0.1 %	14.33 [-3.33, 31.99]
Dean 2000	10	-11 (15.60047)	13	-14 (17.78728)		0.2 %	3.00 [-10.67, 16.67]
Fox 2000	12	1.64 (3.274401)	12	0 (3.274401)		6.6 %	1.64 [-0.98, 4.26]
Gustafsson 2006	17	50.3 (15.7)	15	49 (24.1)		0.2 %	1.30 [-13.00, 15.60]
Horton 2002	27	-3.8 (4.9)	28	-2.9 (4.4)		7.5 %	-0.90 [-3.36, 1.56]
Jang 2015	11	94.8 (22)	13	87 (18.4)		0.2 %	7.80 [-8.60, 24.20]
Jerosch-Herold 2011	74	-31 (23.3)	76	-28.4 (21.1)		0.9 %	-2.60 [-9.72, 4.52]
John 2011	25	44 (15)	23	35 (25)		0.3 %	9.00 [-2.79, 20.79]
Jongs 2012	17	8 (13)	19	6 (11)		0.7 %	2.00 [-5.92, 9.92]
Kemler 2012	18	26 (14)	18	17 (19)		0.4 %	9.00 [-1.90, 19.90]
Kolmus 2012	19	151.5 (7.77)	21	151.5 (7.77)		2.0 %	0.0 [-4.82, 4.82]
Lai 2009	23.66667 (28.27333)		15	14.4 (26.8775)		0.1 %	9.27 [-10.47, 29.01]
Lannin 2003a	14	1 (6.614547)	11	0 (5.863169)		1.9 %	1.00 [-3.90, 5.90]
Lannin 2007a	21	0 (6.034517)	21	1.3 (6.034517)		3.4 %	-1.30 [-4.95, 2.35]
Lee 2007	29	28.4 (9.2)	27	27.9 (9.3)		1.9 %	0.50 [-4.35, 5.35]
Moseley 1997	9	13.5 (11.87939)	9	-1.9 (11.87939)		0.4 %	15.40 [4.42, 26.38]
Moseley 2005	46	0 (5.383214)	47	0.3 (5.441412)		9.4 %	-0.30 [-2.50, 1.90]



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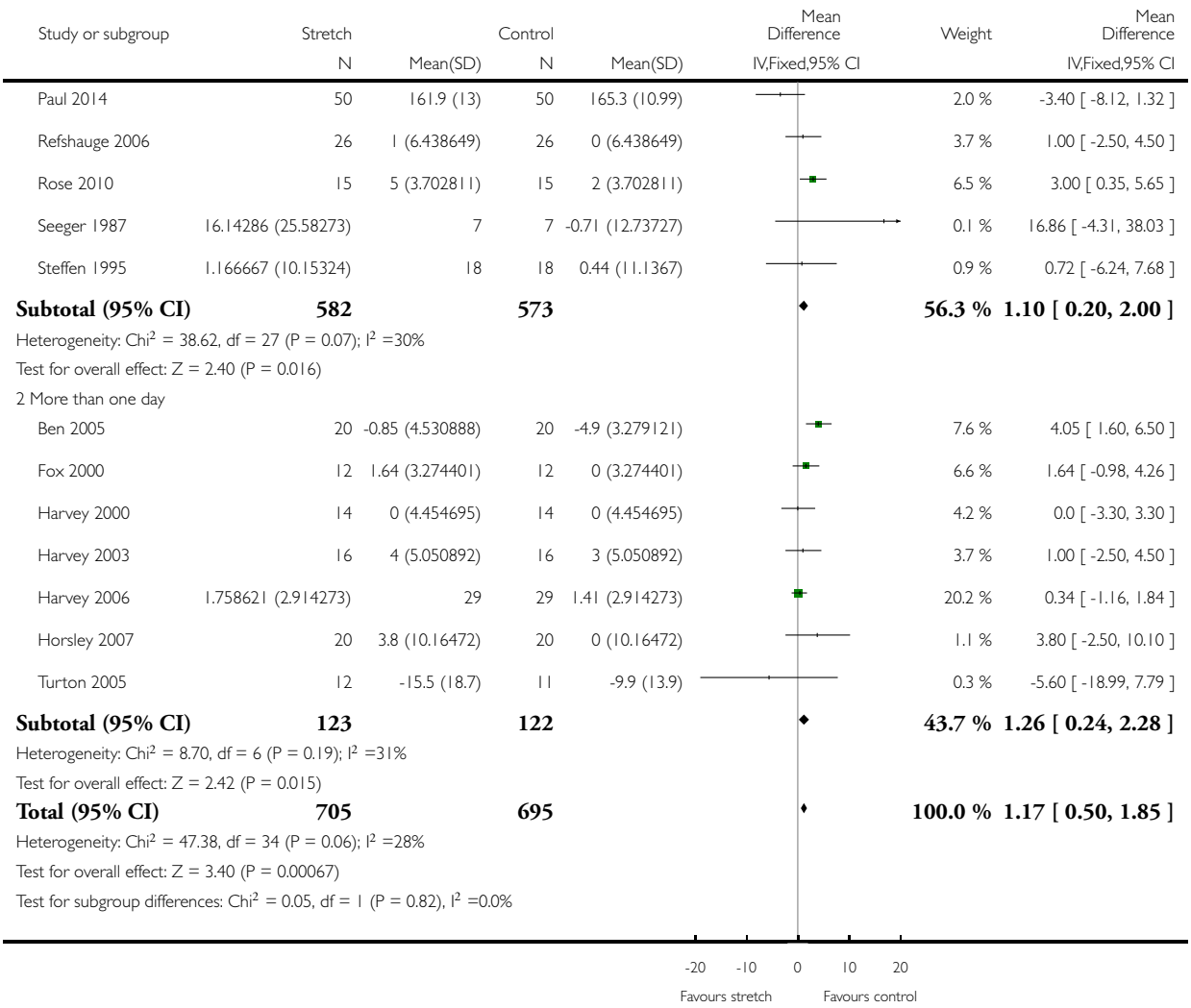

ADDITIONAL TABLES

Table 1. Sensitivity analyses: joint mobility - neurological conditions

Joint mobility - neurological conditions	Pooled results	Randomisation (studies with adequate sequence generation)	Allocation (studies with concealed allocation)	Assessors (studies with blinded assessors)	Dropout rate (studies with ≤ 15% dropouts)

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Table 1. Sensitivity analyses: joint mobility - neurological conditions (*Continued*)

Short-term effects following stretch	2 ° (0 to 3) n = 18	2 ° (0 to 3) n = 16	1 ° (0 to 3) n = 15	2 ° (0 to 3) n = 14	2 ° (0 to 3) n = 13
Long-term effects following stretch	1 ° (-1 to 3) n = 8	1 ° (-3 to 4) n = 6	0 ° (-2 to 2) n = 5	1 ° (-2 to 3) n = 6	0 ° (-2 to 2) n = 6

Results are presented in degrees; mean (95% CI).
n = number of studies included in analysis

Table 2. Sensitivity analyses: joint mobility - non-neurological conditions

Joint mobility - non-neurological conditions	**Pooled results**	**Randomisation (studies with adequate sequence generation)**	**Allocation (studies with concealed allocation)**	**Assessors (studies with blinded assessors)**	**Dropout rate (studies with ≤ 15% dropouts)**
Short-term effects following stretch	1° (-1 to 2) n = 16	1° (-1 to 3) n = 9	-1° (-2 to 1) n = 8	1° (-1 to 3) n = 12	0° (-2 to 1) n = 10
Long-term effects following stretch	-1° (-3 to 2) n = 5	0° (-6 to 7) n = 3	1° (-5 to 7) n = 3	0° (-7 to 7) n = 3	-1° (-3 to 2) n = 5

Results are presented in degrees; mean (95%CI). Studies in which data were no expressed in degrees were excluded from all analyses (Buchbinder 1993, Cox 2009 and Melegati 2003).
n = number of studies included in analysis.

Table 3. Interpretation of results

	Neurological conditions		**Non-neurological conditions**	
	Short-term	**Long-term**	**Short-term**	**Long-term**
Joint ROM	**Ineffective**[1] - HIGH (95% CI; 0 to 3°)	**Ineffective**[1] (95% CI; -1 to 3°)	**Ineffective**[1] - HIGH (95% CI; 0 to 0.3 SD)	**Ineffective**[1] (95% CI; -0.4 to 0.2 SD)
QOL	Not measured	Not measured	**Ineffective**[2] - MOD (95%CI; -0.1 to 0.7 SD)	Not measured
Pain*	Uncertain - LOW (95% CI; -0.1 to 0.5 SD)	Uncertain (95% CI; -0.4 to 0.5 SD)	**Ineffective**[3] - HIGH (95% CI; -0.4 to 0.1 SD)	Uncertain No meta-analysis performed[4]
Spasticity*	Uncertain (95% CI; -0.3 to 0.3 SD)	Uncertain (95% CI; -0.8 to 0.1 SD)	Not relevant for people with non-neurological conditions	Not relevant or people with non-neurological conditions

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Table 3. Interpretation of results (*Continued*)

Activity limitations	Uncertain - LOW (95% CI; -0.1 to 0.5 SD)	Uncertain (95% CI; -0.1 to 0.6 SD)	Uncertain - HIGH (95% CI; -0.2 to 0.3 SD)	Uncertain (95% CI; -0.3 to 0.2 SD)
Participation restrictions	Not measured	Not measured	Uncertain - LOW (95% CI; -0.1 to 0.7 SD)	Uncertain 95% CI; (-0.6 to 0.3 SD)

* Negative value favours stretch

Ineffective = the results rule out a clinically important treatment effect.

The quality of the evidence for the short-term effects was rated using GRADE and is indicated by high, moderate (mod) or low. GRADE was not used to rate the quality of evidence for the long-term effects.

[1] The results rule out a clinically important treatment effect of 5°. Results expressed as SMD were back converted to degrees (see Summary of findings for the main comparison).

[2] The results rule out a clinically important treatment effect equivalent to 10 points on a 160-point scale, and an absolute change and relative change of 5% (see Summary of findings 2).

[3] The results rule out a clinically important treatment effect equivalent to 2 points on a 10-point pain scale, and an absolute change and relative change of 5% (see Summary of findings 2).

[4] A meta-analysis was not performed on the two studies because of clinical heterogeneity between studies (see Results).

APPENDICES

Appendix 1. Cochrane CENTRAL search strategy

#1	MeSH descriptor Contracture explode all trees
#2	contracture*
#3	MeSH descriptor Muscle Spasticity explode tree 1
#4	MeSH descriptor Muscle Hypertonia explode all trees
#5	MeSH descriptor Muscle Rigidity explode tree 1
#6	(spasticity or rigid*)
#7	MeSH descriptor Elasticity explode all trees
#8	elastic*
#9	stiff*
#10	extensib*
#11	flexib*
#12	MeSH descriptor Range of Motion, Articular explode all trees
#13	(range* NEAR/3 (motion* or movement or joint*))
#14	(#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13)
#15	MeSH descriptor Muscle Stretching Exercises explode all trees
#16	stretch*
#17	MeSH descriptor Splints, this term only
#18	splint*
#19	cast*
#20	positioning
#21	MeSH descriptor Orthotic Devices explode all trees
#22	orthotic*

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#23 orthos*
#24 MeSH descriptor Exercise Therapy explode tree 1
#25 thermoplastic*
#26 bracing
#27 brace*
#28 MeSH descriptor Yoga, this term only
#29 yoga
#30 (#15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29)
#31 (#14 AND #30)

Appendix 2. MEDLINE search strategy

1. exp Contracture/
2. contracture$.tw.
3. Muscle Spasticity/
4. Muscle Rigidity/
5. (spasticity or rigid$).tw.
6. exp Elasticity/
7. elastic$.tw.
8. stiff$.tw.
9. extensib$.tw.
10. flexibil$.tw.
11. exp "Range of Motion, Articular"/
12. (range$ adj3 (motion$ or movement or joint$)).tw.
13. or/1-12
14. Muscle Stretching Exercises/
15. stretch$.tw.
16. Splints/
17. splint$.tw.
18. cast$.tw.
19. positioning.tw.
20. exp Orthotic Devices/
21. orthotic$.tw.
22. orthos$.tw.
23. Exercise Therapy/
24. thermoplastic$.tw.
25. bracing.tw.
26. brace$.tw.
27. Yoga/
28. yoga.tw.
29. or/14-28
30. 13 and 29
31. randomized controlled trial.pt.
32. controlled clinical trial.pt.
33. randomized.ab.
34. placebo.ab.
35. drug therapy.fs.
36. randomly.ab.
37. trial.ab.
38. groups.ab.
39. or/31-38

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40. humans.sh.
41. 39 and 40
42. 41 and 30

Appendix 3. Embase search strategy

1. exp Contracture/
2. contracture$.tw.
3. exp Muscle Hypertonia/
4. (spasticity or rigid$).tw.
5. Muscle Length/
6. exp elasticity/
7. elastic$.tw.
8. stiff$.tw.
9. extensib$.tw.
10. flexibil$.tw.
11. exp "joint characteristics and functions"/
12. "range of motion"/
13. (range$ adj3 (motion$ or movement or joint$)).tw.
14. or/1-13
15. muscle stretching/
16. stretch$.tw.
17. splint/
18. splint$.tw.
19. plaster cast/
20. cast$.tw.
21. positioning.tw.
22. orthotics/
23. orthotic$.tw.
24. orthos$.tw.
25. thermoplastic$.tw.
26. bracing$.tw.
27. brace/
28. brace$.tw.
29. yoga/
30. yoga.tw.
31. or/15-30
32. 14 and 31
33. Randomized Controlled Trial/
34. Single Blind Procedure/
35. Double Blind Procedure/
36. Crossover Procedure/
37. random$.tw.
38. factorial$.tw.
39. crossover$.tw.
40. cross over$.tw.
41. placebo$.tw.
42. (doubl$ adj blind$).tw.
43. (singl$ adj blind$).tw.
44. assign$.tw.
45. allocat$.tw.
46. volunteer$.tw.

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47. or/33-46
48. Human/
49. 47 and 48
50. 49 and 32

Appendix 4. CINAHL search strategy

1. Contracture/
2. contracture$.tw.
3. exp Muscle Hypertonia/
4. (spasticity or rigid$).tw.
5. exp Elasticity/
6. elastic$.tw.
7. stiff$.tw.
8. extensib$.tw.
9. flexibil$.tw.
10. "Range of Motion"/
11. (range$ adj3 (motion$ or movement or joint$)).tw.
12. or/1-11
13. Stretching/
14. stretch$.tw.
15. Splints/
16. splint$.tw.
17. Casts/
18. cast$.tw.
19. positioning.tw.
20. Orthoses/
21. orthotic$.tw.
22. orthos$.tw.
23. Therapeutic Exercise/
24. thermoplastic$.tw.
25. bracing.tw.
26. brace$.tw.
27. Yoga/
28. yoga.tw.
29. or/13-28
30. 12 and 29
31. exp Clinical Trials/
32. clinical trial.pt.
33. (clinic$ adj trial$1).tw.
34. ((singl$ or doubl$ or trebl$ or tripl$) adj (blind$3 or mask$3)).tw.
35. randomi?ed control$ trial$.tw.
36. Random assignment/
37. random$ allocat$.tw.
38. placebo$.tw.
39. Placebos/
40. Quantitative studies/
41. allocat$ random$.tw.
42. or/31-41
43. 30 and 42

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Appendix 5. SCI-EXPANDED search strategy

#1 Topic=(contracture*)
#2 Topic=(spasticity) OR Topic=(rigid*)
#3 Topic=(elastic*)
#4 Topic=(stiff*)
#5 Topic=(extensib*)
#6 Topic=(flexibil*)
#7 Topic=(range* SAME (motion* OR movement OR joint*))
#8 #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1
#9 Topic=(stretch*)
#10 Topic=(splint*)
#11 Topic=(cast*)
#12 Topic=(positioning)
#13 Topic=(orthotic* OR orthos*)
#14 Topic=(thermoplastic*)
#15 Topic=(bracing OR brace*)
#16 Topic=(yoga)
#17 #16 OR #15 OR #14 OR #13 OR #12 OR #11 OR #10 OR #9
#18 #17 AND #8
#19 TS= clinical trial* OR TS=research design OR TS=comparative stud* OR TS=evaluation stud* OR TS=controlled trial* OR TS=follow-up stud* OR TS=prospective stud* OR TS=random* OR TS=placebo* OR TS=(single blind*) OR TS=(double blind*)
#20 #19 AND #18

Appendix 6. PEDro search strategies

The first PEDro search will combine the following terms using "OR": [Abstract & Title field] stretch*, splint*, cast*, position*, brace*, bracing*, orthos*, orthotic*.
The second PEDro search will combine the following terms using "AND": [Therapy field] stretching, mobilisation, manipulation, massage [Problem field] muscle shortening, reduced joint compliance.
The third PEDro search will combine the following terms using "AND": [Therapy field] orthosis, taping, splinting [Problem field] muscle shortening, reduced joint compliance

WHAT'S NEW

Last assessed as up-to-date: 1 November 2015.

Date	Event	Description
20 December 2016	New citation required but conclusions have not changed	Methods were updated in accordance with current recommendations of The Cochrane Collaboration: 'Risk of bias' assessment and 'Summary of findings' tables were added
12 December 2016	New search has been performed	This is an updated version of the original 2010 Cochrane Review. In the original 2010 Review we divided effects for all outcomes into immediate (less than one day), short-term (less than one week) and long-term effects (more than one week). In the 2016 updated version we divided effects for all outcomes into

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(*Continued*)

		short-term (less than one week) and long-term (more than one week) effects. That is, we combined the immediate and short-term effects into one category This updated version contains an additional 14 studies (744 participants). Most of the additional studies (10 studies) involve people with non-neurological conditions and hence provides more conclusive evidence about the effects of stretch in this population. This updated version (like the original 2010 Review) indicates that there is high quality evidence that stretch does not have clinically important effects on joint mobility in people with and without neurological conditions. However, this updated version provides additional moderate and high quality evidence that stretch does not have clinically important short-term effects on quality of life or pain, respectively, in people with non-neurological conditions

HISTORY

Protocol first published: Issue 4, 2008

Review first published: Issue 9, 2010

Date	Event	Description
1 June 2008	Amended	CMSG ID A030-R

CONTRIBUTIONS OF AUTHORS

Original review

Owen M Katalinic was responsible for designing the review protocol, writing the protocol and report, conducting the search, screening potentially eligible studies, extracting and analysing data, interpreting results, updating reference lists and creating 'Summary of findings' tables.

Lisa A Harvey was responsible for designing the review protocol and screening potentially eligible studies. She contributed to writing the report, extracting and analysing data, interpreting results and creating 'Summary of findings' tables.

Robert D Herbert conducted the meta-regression analyses and contributed to the design of the review protocol, writing the report, arbitrating potentially eligible studies, extracting and analysing data and interpreting results.

Natasha A Lannin contributed to data extraction and provided feedback on the report.

Anne M Moseley and Karl Schurr provided feedback on the report.

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2016 revised review

Owen M Katalinic was responsible for checking some analyses and data extraction, arbitrating potentially eligible studies, contributing to the interpretation of results and providing feedback on the report.
Lisa A Harvey was responsible for changes to the protocol, conducting the updated search, screening potentially eligible studies, extracting and analysing data, extracting study details for the 'Characteristics of included studies' tables, assessing risk of bias, interpreting results, updating the report, updating reference lists and creating 'Summary of findings' tables.
Robert D Herbert was responsible for extracting data, arbitrating potentially eligible studies, contributing to the interpretation of results and providing feedback on the report.
Natasha A Lannin and Anne M Moseley were responsible for extracting study details for the 'Characteristics of included studies' tables, assessing risk of bias, contributing to the interpretation of results and providing feedback on the report.
Karl Schurr was responsible for screening potentially eligible studies, contributing to the interpretation of results and providing feedback on the report.

DECLARATIONS OF INTEREST

Lisa A Harvey: no financial interest in this intervention but has authored trials reported in this review.

Owen M Katalinic: no financial interest in this intervention and has not authored trials reported in this review

Robert D Herbert: no financial interest in this intervention but has authored trials reported in this review.

Anne M Moseley: no financial interest in this intervention but has authored trials reported in this review.

Natasha A Lannin: no financial interest in this intervention but has authored trials reported in this review.

Karl Schurr: no financial interest in this intervention and has not authored trials reported in this review.

SOURCES OF SUPPORT

Internal sources

- The George Institute for Global Health, The University of Sydney, Australia.
- Department of Physiotherapy, Greater Newcastle Sector, Hunter New England Health, Australia.
- Moorong Spinal Unit, Royal Rehabilitation Centre Sydney, Australia.
- John Walsh Centre for Rehabilitation Research, Kolling Institute, The University of Sydney, Australia., Australia.

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Differences between original 2010 Review and protocol

In the protocol we intended to include studies that compared the effects of competing interventions (that is, compared one type of stretch to a different type of stretch). This produced an unmanageable number of comparisons. Therefore we elected to exclude studies comparing the effects of competing interventions.
In the protocol we also stated that we would utilise first-period data for cross-over studies as first preference. In the review, we used combined data in preference to first-period data. This method of using combined data yields more accurate weighting for cross-over studies in meta-analyses than using first period data only (Curtin 2002).
In the protocol we stated that we would include data from all time points. In the review, we used one set of data per time point. This was always our intention but poorly expressed in our protocol.

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The changes to the protocol were approved by Cochrane Musculoskeletal Editorial Board.

Differences between original 2010 Review and the 2016 updated version

In the original 2010 Review we divided effects for all outcomes into immediate (less than one day), short-term (less than one week) and long-term effects (more than one week). In the 2016 updated version we divided effects for all outcomes into short-term (less than one week) and long-term (more than one week) effects. That is, we combined the immediate and short-term effects into one category. We used a sensitivity analysis to explore the possibility of immediate effects of stretch due to viscous deformation.

In the 2016 updated version we also made a change to the 'Risk of bias' assessment on the recommendation of Cochrane. That is, we assessed the risk of detection bias separately for measurements of objective and self-reported outcomes.

INDEX TERMS

Medical Subject Headings (MeSH)

*Range of Motion, Articular; Contracture [prevention & control; *therapy]; Joints; Muscle Stretching Exercises [*methods]; Quality of Life; Randomized Controlled Trials as Topic; Time Factors

MeSH check words

Humans

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