The effects of hamstring stretching on range of motion: a systematic literature review
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CRD summary
This review sought to determine the most effective stretching regimes for improving flexibility of hamstring muscles in asymptomatic people. The authors concluded that the limited evidence from generally poor-quality studies prevented them from drawing conclusions about the most effective approach. This was generally a well-conducted review and these conclusions are likely to be reliable.

Authors’ objectives
To determine the most effective stretching regimes for improving the flexibility of hamstring muscles in asymptomatic people.

Searching
MEDLINE, CINAHL, SPORTDiscus and EMBASE were searched from inception to November 2004 for studies published in English; the search terms were reported. The reference lists in identified studies were checked. Authors of studies published as abstracts were contacted for details of full or in-press publications, but studies reported only as abstracts were excluded.

Study selection
Study designs of evaluations included in the review
Experimental studies including randomised controlled trials (RCTs) and pre-test post-test cohort studies were eligible for inclusion.

Specific interventions included in the review
Studies of interventions that included commonly or clinically used hamstring stretching were eligible for inclusion. Studies of instrumental stretching were excluded. The included studies used various techniques of stretching, such as static, active, ballistic and proprioceptive neuromuscular facilitation (PNF), and various positions (e.g. supine, standing and seated). The intensity of the interventions ranged from 10 to 80 seconds per stretch, with interventions delivered in single sessions, several times a day or several times a week, for time periods of up to 10 weeks, with and without warm-up sessions. The studies used a variety of control interventions (details were reported).

Participants included in the review
Studies of healthy people aged 14 to 60 years with no orthopaedic or neurological problems that could reduce the potential gain in range of motion (ROM) were eligible for inclusion.

Outcomes assessed in the review
Studies that assessed ROM at the knee or hip were eligible for inclusion. The outcomes had to be reported in degrees, or be able to be converted to degrees (i.e. sit and reach). The included studies measured knee extension and straight leg raising at various times after stretching.

How were decisions on the relevance of primary studies made?
One reviewer screened abstracts and two reviewers independently selected studies from retrieved full reports. Any disagreements were resolved by reaching consensus, with the help of a third reviewer if required.

Assessment of study quality
All studies were assessed and scored using the Physiotherapy Evidence Database (PEDro) scale, which evaluates: specification of eligibility criteria; random allocation; concealment of allocation; baseline similarity of the treatment groups; blinding of the participants, therapists and assessors of outcomes; follow-up 85% or more; at least one key
variable analysed on an intention-to-treat basis; statistical analysis of differences between treatment groups; and the reporting of point estimates and variability. The maximum possible quality score was 10 points. Three reviewers independently assessed validity. Any disagreements were resolved by reaching consensus, with the help of a fourth reviewer if required.

Data extraction
Three reviewers independently extracted the data using a standardised form. Any disagreements were resolved through discussion and consensus, with the help of a fourth reviewer if required. The extracted data included the change in ROM and statistical differences between the treatment groups.

Methods of synthesis
How were the studies combined?
The studies were discussed in a narrative under the following headings: stretching position, stretching technique, stretching duration; and use of warm-up exercises. The range of mean gain in ROM across studies was presented for each position (standing, seated and supine for leg and knee) and for the control groups combined, and for each stretching technique (static and PNF for knee extension and straight leg raised).

How were differences between studies investigated?
Studies that directly compared different techniques, duration and use of warm-up exercises were discussed separately. Differences were discussed with respect to quality.

Results of the review
Twenty-eight studies (n=1,338) were included, of which 23 were RCTs.

The studies were generally of a poor quality: the scores ranged from 2 to 8 out of a possible 10 (mean score 4.3). Only 6 studies scored between 6 and 8 points. Most studies reported point estimates and variability for outcomes, methods used for statistical analysis and randomisation. Flaws included a lack of allocation concealment and a lack of blinding of the participants, therapists and outcome assessors.

Stretch position.
All stretching positions showed gains in ROM motion compared with the control groups. The minimum gain in ROM was 5.2 degrees with straight leg raise/seated; the greatest gain reported was 14.3 degrees with straight leg raise/standing; and the range of means for the control groups was -2.9 to 3.0 degrees, based on 11 studies.

Stretching technique and duration.
Studies using static stretching showed greater gains than studies using PNF. Four studies directly compared stretching techniques. No technique was found to be consistently better than any other. The studies showed improvements with static stretching compared with dynamic stretching (1 study) and slow-reversal-hold compared with a static intervention (1 study). There was no significant difference between static and ballistic exercises (1 study) or between PNF and static exercises (1 study).

Four studies directly compared stretching duration. Studies showed that durations of 30 seconds and 60 seconds were equally effective and better than 15 seconds (1 study); one stretch daily for 30 seconds was as effective as one stretch daily for 60 seconds and three stretches daily for 30 or 60 seconds (1 study); six stretches daily for 10 seconds were as effective as two stretches for 30 seconds (1 study); and three stretches for 15 seconds were as effective as nine stretches for 5 seconds (1 study).

Warm-up.
Two higher quality studies (scores 6 and 8) assessed the effects of warm-up exercises but neither found any effect of warm-up exercises on the ROM with stretching.
Authors' conclusions
The studies showed that a variety of hamstring stretching techniques, positions and durations increased ROM. However, limited evidence from generally poor-quality studies prevented the authors from drawing firm conclusions about the most effective hamstring exercises.

CRD commentary
The review question was clear in terms of the study design, intervention, participants and outcomes. Several relevant sources were searched, but no attempts were made to minimise language or publication bias; the reviewers acknowledged these limitations. Two or more reviewers independently selected studies, assessed validity and extracted the data, thus reducing the potential for bias and errors. Validity was assessed using specified established criteria and results of the assessment were reported. Very little information on the participants and methods used to select them was given, although this might have been due to a lack of information in the primary studies. Thus, although only healthy people were included, it is difficult to ascertain which populations these results might apply to. In addition, no information was given on the validity of the methods used to measure changes in ROM.

The reviewers combined data from treatment arms across studies rather than comparing treatment with controls within studies, so it is not clear if all studies showed greater effects of the intervention compared with the controls. RCTs and pre-test post-test studies were not discussed separately. The benefits of hamstring stretching were only found in poor-quality studies, which supports the authors' conclusion regarding the inability to draw conclusions. The evidence presented was not sufficient to allow comment on the consistency of effects of strengthening exercises on flexibility across studies.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that future systematic reviews and studies should aim at determining the most effective interventions in symptomatic people.

Bibliographic details

PubMedID
16001909

DOI
10.2519/jospt.2005.35.6.377

Indexing Status
Subject indexing assigned by NLM

MeSH
Exercise; Humans; Muscle, Skeletal /physiology; Range of Motion, Articular; Thigh /physiology; Time Factors

AccessionNumber
12005000398

Date bibliographic record published
30/04/2006

Date abstract record published
Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.