What is already known on this topic

Radiotherapy is commonly given to patients with inoperable non-small cell lung cancer in the United Kingdom

One or two fractions of palliative radiotherapy can control thoracic symptoms

What this study adds

In the group of patients with no symptoms or only minimal symptoms, palliative thoracic radiotherapy can be safely deferred until significant thoracic symptoms appear

Compared with immediate, palliative radiotherapy, no evidence exists that such a policy affects patients' survival or levels of activity, anxiety, or depression

cal Research Council Lung Cancer Working Party.

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Contributors: see bmj.com

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ELPS

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Effects of stretching before and after exercising on muscle soreness and risk of injury: systematic review

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Abstract

Objective To determine the effects of stretching before and after exercising on muscle soreness after exercise, risk of injury, and athletic performance.
Method Systematic review.
Data sources Randomised or quasi-randomised studies identified by searching Medline, Embase, CINAHL, SPORTDiscus, and PEDro, and by recursive checking of bibliographies.
Main outcome measures Muscle soreness, incidence of injury, athletic performance.
Results Five studies, all of moderate quality, reported sufficient data on the effects of stretching on muscle soreness to be included in the analysis. Outcomes seemed homogeneous. Stretching produced small and statistically non-significant reductions in muscle soreness. The pooled estimate of reduction in muscle soreness 24 hours after exercising was only 0.9 mm on a 100 mm scale (95% confidence interval −2.6 mm to 4.4 mm). Data from two studies on army recruits in military training show that muscle stretching before exercising does not produce useful reductions in injury risk (pooled hazard ratio 0.95, 0.78 to 1.16).
Conclusions Stretching before or after exercising does not confer protection from muscle soreness. Stretching before exercising does not seem to confer a practically useful reduction in the risk of injury, but the generality of this finding needs testing. Insufficient research has been done with which to determine the effects of stretching on sporting performance.

Introduction

Many people stretch before or after engaging in athletic activity. Usually the purpose is to reduce muscle soreness after exercising, to reduce risk of injury, or to improve athletic performance.[1–7]

This systematic review synthesises research findings of the effects of stretching before and after exercising on delayed onset muscle soreness, risk of injury, and athletic performance.

Methods

Inclusion and exclusion criteria

The review included English language randomised or quasi-randomised studies that investigated the effects of any stretching technique, immediately before or after exercising, on delayed onset muscle soreness, risk of injury, or athletic or sporting performance. Studies were included only if stretching was conducted before or after exercising.

Search strategy

Relevant studies were identified by searching Medline (1966 to February 2000), Embase (1988 to February 2000), CINAHL (1982 to January 2000), SPORTDiscus

(1949 to December 1999) and PEDro (to February 2000). More details are given on bmj.com

Assessment of study quality

Methodological quality was assessed independently by two assessors with the PEDro scale.[8 9] Only studies scoring at least 3 were considered in the initial analysis.

Data extraction

To facilitate pooling, soreness scores were converted to percentages of the maximum possible score. For ease of interpretation, soreness data are reported as mm on a 100 mm analogue scale; negative values favour stretching.

Data synthesis

Results of comparable studies were pooled in meta-analyses. Meta-analysis of continuous outcomes (scores for muscle soreness) was performed with a fixed effects model.[10 11] The time to event data, obtained directly from the authors, were analysed with Cox regression.

Results

Search results

Six studies investigated effects of stretching on delayed onset muscle soreness, and two investigated effects of stretching on the risk of injury (see bmj.com). Only one small and inconclusive study investigated effects of stretching on athletic performance, so these are not discussed further in this review.[12]

Methodological quality of included studies

The methodological quality of the studies was generally moderate. The range of quality scores was 2-7 (mean 4.1) out of 10. Often a report did not clearly specify that a criterion was met, and consequently we scored the study as not satisfying the criterion. Two studies did not provide sufficient data to permit inclusion in the meta-analysis.[13 14]

Effect of stretching on delayed onset muscle soreness

The five studies included were reasonably homogeneous with respect to participants' characteristics and interventions. In all studies, participants were healthy young adults. Total stretch time per session varied from 300 seconds to 600 seconds, with the exception of one study in which total stretch time was only 80 seconds.[15] Three studies evaluated stretching after exercising, and two evaluated stretching before exercising.[15–18] As there was no evidence of heterogeneity in the outcomes of the studies (P=0.97 at 24 hours, P=0.99 at 48 hours, and P=0.53 at 72 hours), we combined studies using stretching both before and after exercising in the meta-analysis (fig 1).

The pooled mean effects of stretching on muscle soreness at 24, 48, and 72 hours after exercising were −0.9 mm (95% confidence interval −4.4 mm to 2.6 mm, P=0.70, n=77), 0.3 mm (−4.0 mm to 4.5 mm, P=0.45, n=77), and −1.6 mm (−5.9 mm to 2.6 mm, P=0.77, n=67), respectively. Sensitivity analysis indicated that the choice of threshold quality score and assumptions about correlations between repeated measures had little effect on this result.

Effect of stretching on risk of injury

Two studies evaluated the effects of stretching before exercising on the risk of specific leg injuries or all leg injuries in new military recruits undergoing 12 weeks of initial training.[19 20] Recruits were considered to have sustained an injury if they were unable to return to full duties without signs or symptoms in three days. The two studies yielded similar estimates of risk reduction (hazard ratios 0.92 (0.52 to 1.61) and 0.95 (0.77 to 1.18); fig 2).

Risks of injury in the two studies differ because injury is defined differently. Time to event data (2630 subjects, 65 platoons) were combined; 1284 subjects (32 platoons) were allocated to stretch groups and 1346 (33 platoons) to control groups. The discrepancy in sample size occurred because subjects were quasi-randomly allocated to an odd number of platoons by military personnel who did not participate in the studies, and then platoons were randomly allocated to groups by the experimenters. A total of 181 injuries occurred in stretch

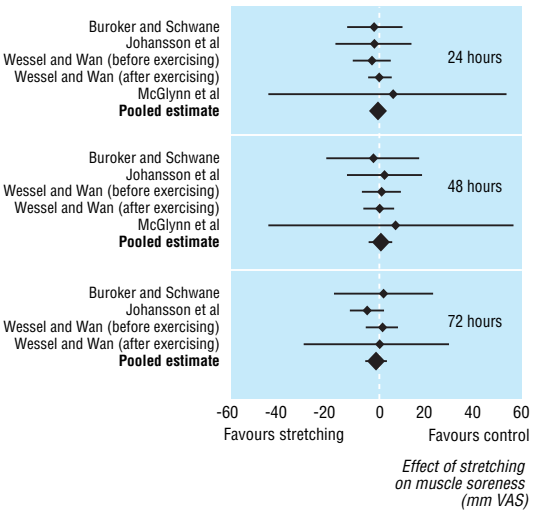

Fig 1 Effects of stretching on delayed onset muscle soreness at 24 hours, 48 hours, and 72 hours after exercise. (VAS=visual analogue scale)[15–18]

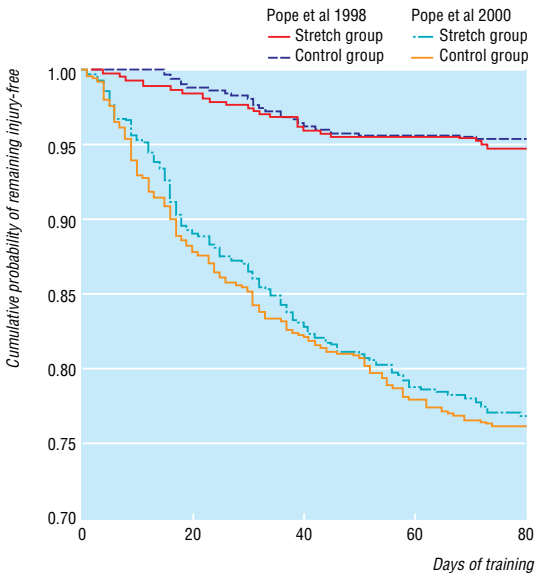

Fig 2 Survival curves from studies of Pope at al 1998 and Pope et al 2000, showing risk of injury in army recruits undergoing training[19 20]

What is already known on this topic

Reviews of the effects of stretching before exercise have drawn conflicting conclusions

The literature on effects of stretching before and after exercising on muscle soreness and risk of injury has not been systematically reviewed

What this study adds

Stretching before and after exercising does not confer protection from muscle soreness

Stretching before exercise does not seem to confer a practically useful reduction in the risk of injury

groups and 200 injuries in control groups. Survival curves for stretch and control groups were similar (fig 2). The pooled estimate of the hazard ratio for the stretch factor was 0.95 (0.78 to 1.16, P=0.61).

Discussion

Eliminating potential bias

Our results are consistent with at least one review of the effects of stretching, but not others.[21–23] Unlike earlier reviews, we used a systematic review methodology to eliminate potential sources of bias as far as possible, but this does not guarantee the absence of bias. Our review may have been biased by publication bias or by inclusion only of studies reported in English.[24 25] Both factors would be expected to inflate estimates of the effects of treatments, yet we found that stretching has no effect on delayed onset muscle soreness or on risk of injury. When we performed a less sensitive search for studies in languages other than English we found no studies that satisfied the inclusion criteria. The PEDro scale, which we used to discriminate between studies of different quality, has not been fully validated. Use of the PEDro scale is, however, unlikely to have biased our conclusions as study findings were consistent (fig 1).

Effect of stretching on delayed onset muscle soreness

The results of five studies (77 subjects) imply that stretching reduces soreness in the 72 hours after exercising by, on average, less than 2 mm on a 100 mm scale. Most athletes will consider effects of this magnitude too small to make stretching to prevent later muscle soreness worth while.

Effects of stretching on risk of injury

The pooled estimate from two studies was that stretching decreased the risk of injury by 5%. This effect was statistically non-significant. Even if this effect was not simply a sampling error it would not be large enough to be of practical significance. In army recruits, whose risk of injury in the control condition is high (approximately 20% over the training period of 12 weeks), a 5% reduction in relative risk implies a reduction in absolute risk of about 1%. Thus, on average, about 100 people stretch for 12 weeks to prevent one injury and (if the hazard reduction was constant) the average subject would need to stretch for 23 years to prevent one injury.[19] Most athletes are exposed to lower risks of injury so the absolute risk reduction for most athletes is likely to be smaller still.[26 27]

Although these data imply that the muscle stretching protocol used in these studies does not appreciably reduce risk of injury in army recruits undergoing military training, it is not possible to rule out with certainty a clinically worthwhile effect of other stretch protocols on risk of injury in other populations. It would be particularly interesting to determine if more prolonged stretching carried out by recreational athletes over many months or years can produce meaningful reductions in risk of injury.

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