
A SYSTEMATIC REVIEW ON THE EFFECT OF STRETCHING IN SPORTS INJURY PREVENTION

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ABSTRACT

Introduction:

Although stretching increases soft tissue flexibility and joint range of motion, numerous studies demonstrated contradictory findings as to its effect in injury prevention. Aim: The purpose of this systematic review is to assess the effectiveness of stretching on the prevention of injuries.

Methodology:

An electronic search using MEDLINE, SCIENCE DIRECT, COCHRANE, EBSCOHOST, SPORTDiscus and CINAHL databases, checking the references. Randomised control trials (RCTs) and cohort studies investigating stretching as an injury prevention measure published in the last decade were selected in this review. Methodological quality was assessed using the Critical Appraisal Skills Programme (CASP) tool.

Results:

Two RCTs and two prospective cohort studies all of high quality were included in this analysis. One cohort study found that stretching reduced the incidence of exercise related injuries. Two RCTs and one cohort study found that stretching did not produce practical reduction on the occurrence of injuries.

Conclusion:

Stretching exercises does not give a practical useful reduction in the risk of injuries. Not enough recent research has been done to draw definitive conclusion on the effect of stretching in injury prevention. Well designed studies are needed to shed light as to the effect of stretching in exercise-related injury risk reduction.

Keywords:

Effect, stretching, sports, injury prevention

Introduction

Many people are extensively engaging in physical activities and sports for several reasons ranging from profession (Hägglund, Waldén, & Ekstrand, 2004) to the fight against chronic diseases of lifestyle (Lee & Laffrey, 2006) and better quality of life (Mulvihill, Rivers & Aggleton, 2000). There has been an increase in the number of people at risk for injuries with the resultant upsurge in participation in sporting activities (Leininger, Knox, & Comstock, 2007), thus the call for injury prevention. It is believed that stretching is one of the fundamental procedures that prevent injuries (Cabbie, Brunell, Finch, Wajswelner, & Orchard, 2006) and it is extensively encouraged among athletes in different literature (Arnheim & Prentice, 1993; Brukner & Khan, 1993). Many studies have been done determining the effect of stretching either before or after exercises and have demonstrated contradictory findings (Yeung & Yeung, 2001). Likewise, numerous studies documented the effect of stretching on the increase of soft tissue flexibility and joint range of motion (Magnusson, Simonsen, Aagaard, Sorensen, & Kjer, 1996; Harvey, Herbert, & Crosbie, 2002) nevertheless there is inconclusive evidence as to its effect on the reduction of the risk or the occurrence of injuries. However, the debate continues whether stretching does influence injury prevention. Therefore, the purpose of this systematic review is to assess the effectiveness of stretching on the prevention of injuries.

METHODS

This review is based on information obtained from peer reviewed published articles for the period of January 1998 to April 2008. In accordance with the aim of this review, the inclusion criteria for the review was all studies that used stretching as an

intervention, included a comparison group, and had some form of injury risk as an outcome. This review included randomised or quasi-randomised full text accessible studies investigating the effect of any stretching exercise on any sport or any exercise-related activity injury. This review excluded studies investigating the effect of stretching on performance as well as studies with abstracts only. Articles published before January 1998 was also excluded from this study.

Search strategy

A computer search of the literature was conducted to retrieve relevant articles using MEDLINE, SCIENCE DIRECT, COCHRANE, EBSCOHOST, SPORTS Discus and CINAHL databases. In addition, all pertinent citations from the references of these papers were also reviewed. Experts in the field were also contacted to locate extra studies. Furthermore, a manual search was conducted for any relevant studies not recovered by other methods. The following key terms were used: Stretch*OR flexib*; Sprain OR strain OR injur*; Muscle OR tendon OR ligament; Sport OR athlet* OR activ* OR exercis*; Prevent* OR avoid*. They were combined with the optimum search terms as described by Dickersin, Scherer and Lefebvre (1994).

Search results

The search generated a total number of 333 articles in which 42 were found relevant to this topic. The articles were then further assessed and 33 were excluded because they did not fulfil the inclusion criteria. An article which was duplicated from one source to another was counted for the first source that it was retrieved from. Thus, a total number of 9 articles were retained. Table 1 gives details of findings from each search strategy.

Table 1: Search results

Database	Hits	Included	Excluded	Retained	Duplicated	Total
Academic search premier	86	9	6	3	0	3
Medline	25	7	5	3	2	1
ERIC	2	1	1	0	0	0
CINAHL	30	6	4	2	2	0
SPORT Discuss	129	8	6	2	2	0
Pubmed	32	1	0	1	1	0
PEDro	9	4	0	4	2	2
Science direct	12	1	0	1	1	0
Cochrane library	3	1	0	1	1	0
Manual search	5	4	1	3	0	3

Assessment of study quality

Of the 9 articles, 2 RCT's and 2 prospective cohort studies were retained whereas 4 systematic reviews and 1 retrospective cross-sectional series were excluded. After selection of studies of acceptable designs, the in-depth assessment of their methodological quality was done. The included studies were scored using the Critical Appraisal Skills Programme (CASP) tool (CASP, 2006). The CASP was developed by the Public Health Resource Unit of the National Health Service (NHS) in the United Kingdom with the aim of enabling individuals to develop the skills to find and make sense of research evidence, helping them to put knowledge into practice (CASP, 2006).

According to Clyde (2006), it has some values in raising awareness of the need for critical assessment of research as a basis for evidence-based practice. The Randomised Controlled Trials (RCTs) were scored out of 13 whereas cohort studies were scored out of 10 according to the presence of criteria such as random allocation and concealment, blinded subjects or therapists or assessors, precise results, appropriate statistical analysis, enough number of participants, number and follow up of dropouts. The quality of each study was classified as high (7-10/10 or 9-13/13), moderate (4-6/10 or 5-8/10) and poor (1-3/10, 1-4/13).

Table 2: Type of study designs

Study designs	No. of studies	Authors
RCT'S	2	Pope, R.P., Herber, R., & Kirwan, J. (1998)
		Pope, R.P., Herber, R., Kirwan, J., & Graham, B.J (2000)
Prospective cohort study	2	Arnason, A., Andersen, T.E., Holme, I., Engegretsen., & Bahr, R. (2008)
		Harting, D.E., & Hederson, J.M. (1999)

Subgroup analysis was done according to the study design. All articles were further screened using the CASP appraisal tools and each citation was

evaluated for quality. The table 3 details each study score.

Table3: Quality scores of studies

Type of study	Authors	score
RCT	Pope, R.P., Herber, R., & Kirwan, J. (1998)	10/13
	Pope, R.P., Herber, R., Kirwan, J., & Graham, B.J (2000)	11/13
Prospective cohort study	Arnason, A., Andersen, T.E., Holme, I., Engegretsen., & Bahr, R. (2008)	8/10
	Harting, D.E., & Hederson, J.M. (1999)	7/13

Results

From the nine studies that met the inclusion criteria, two controlled studies have been published that specifically addressed the effect of stretching in the prevention of injury. For the purpose of this review the two RCTs will be reviewed and since there are few of them, it was opted to include the two prospective cohort studies. Table 4 shows description of each study included in the review. One of the two cohort studies found out that lower extremity overuse injuries was significantly lower in the intervention group (29%) compared with the control group (17%) (P=0.02) (RR=0.63, 95% CI 0.41-0.99) following introduction of hamstring stretching added to the normal basic training programme (Harting, & Henderson, 1999). This study further found a statistically significant difference (P<0.001) between the changes in the flexibility of the hamstring muscles between the intervention and the control group. The results of this study are different from the other cohort study conducted among soccer teams which found no significant difference in the incidence of hamstring strains between the intervention and the control teams (RR: 1.53, 95% CI 0.76-3.08) following hamstring flexibility training (Arnason et al., 2008). This study further found no difference in the incidence of hamstring strains between the

intervention teams and all the teams the previous year (RR: 1.03, 95% CI 0.59-1.79) or between the two seasons for the intervention group only (RR: 0.89, 95% CI 0.42-1.85).

One RCT evaluated the effect of stretching before exercising on the risk of injury (Pope et al., 1998). The results of this study show no significant effect of pre-exercise stretching on the risk of incurring one of the five selected injuries (tendon Achilles lesions, lateral ankle sprains, stress fractures of the foot or tibia periostitis of the tibia and anterior tibial compartment syndrome) (HR=0.92, 95% CI 0.52-1.61). According to the authors, small but clinically worthwhile effects may have gone undetected due to low statistical power therefore these results could be treated with caution. In addition, ranges of motion of the ankle dorsiflexion were measured and it was found that flexibility was a strong predictor of injury risk (Likelihood Ratio LR=4.97; df=1; p=0.03). The findings of the second RCT conducted by the same authors (Pope et al., 2000) show that there was no significant effect of pre-exercise stretching on all injury risk (Hazard Ratio HR= 0.95; 95% CI 0.77-1.18). Moreover, there was no effect of stretching observed when examining soft tissues injuries (HR=0.83, 95% CI 0.63-1.09) or bone injuries separately (HR=1.23, 95% CI 0.86-1.76).

Table 4: Description of studies included in systematic review

Reference	Design	Country	Subjects	Intervention	Outcome
Harting & Henderson 1999	Prospective cohort study	USA	298 army recruits in two companies with average age 20 years	1) 148 recruits: static hamstring stretch, 3 times daily 2) 148 recruits controls: no stretching programme	Incidence of lower extremity overuse injuries
Arnason et al., 2008	Prospective cohort study	Norway	14 soccer teams of 18-24 players/team in 1 soccer seasons (2001)	1) 7 teams: warm up stretching and flexibility straining programme 2) 7 teams: no use of the intervention programme	Incidence of hamstring strains
Pope et al., 1998	Cluster randomized	Australia	1093 Army recruits (26 platoons) in 12-week basic training aged 17-35 years	1) 549 recruits: two 20-s stretches of calf muscles before physical exercises 2) 544 recruits: two 20-s stretches of wrist and triceps before physical exercises	Incidence of soft tissue injuries
Pope et al., 2000	Cluster randomized	Australia	1538 army recruits (39 platoons) in 12-week basic training aged 17-35 years	1) 735 recruits: 20-s stretches of 6 major leg muscle groups before physical exercise 2) 803 recruits: no stretching programme	Incidence of lower limb injury by body area and type

DISCUSSION

This review looked at available literature where the relationship between stretching and injury prevention was examined. The reviewed studies show conflicting results which could be explained by a number of differences like the intervention, the outcomes used and the methodological quality of studies.

Intervention used (type of stretching)

The intervention protocol varied across studies both in duration of stretch and the number of sessions. The two RCTs and one cohort study by Harting and Henderson, (1999) used sustained stretch while Arnason et al. (2008) used hold relax technique. According to Shrier and Gossal (2000) sustained stretching or static stretching is a slow, sustained

muscle lengthening that is held for 15–60 seconds whereas hold relax is a stretching technique that often utilizes a partner who briefly resists contraction of stretched muscle groups, after which the muscles are relaxed while the partner passively stretches the muscle group. Hold relax is one of the techniques of proprioceptive neuromuscular facilitation (PNF) (Osternig, Robertson, Troxel, & Hansen, 1990). The two RCTs showed no significant reduction in injury risk which is in disagreement from the results of the cohort study that used the same technique. One of the major differences is that Harting and Henderson (1999) utilized four stretching sessions per day (three sessions added to the routine morning stretching session) (Table 4) whereas the two RCTs used only one session. This would be explained by the

conclusions made by DePino, Webright and Arnold (2000) and Moller, Ekstrand, Oberg and Gillquist, (1985) that the duration of increased flexibility after stretching is from 6 to 90 minutes although an extensive programme of several weeks duration has been documented to produce increased flexibility that persist for several weeks (Zebas, & Rivera, 1985). It is difficult to draw conclusions by comparing the findings of the RCTs and the cohort study. Therefore, there is a need of extensive studies investigating the effect of stretching in injury prevention based on the number of repetitions in the stretching sessions.

The results of the cohort study conducted by Arnason et al. (2008) which used the hold relax method concur with the two RCTs. It has been found in the literature that the PNF techniques increased flexibility better than the sustained stretching techniques though some results have not been statistically significant (Etnyre & Abraham, 1986; Lucas, & Koslow, 1984). However, there are no studies which have been found investigating the effect of different stretching techniques on the reduction of injuries. This shows how it is difficult to compare these studies because they differ in their designs and the stretching techniques used. Similarly, it is difficult to compare and draw conclusions from the two cohort studies due to unsuitable study design.

Even though the two RCTs used the same stretching protocol (static stretching during warm up before training), they differ from the repetition of the stretch to a muscle group during one session (Table 4). It has been documented that a 15-s or 30-s passive stretch is more effective than shorter duration stretches (Walter, Figoni, Andres, & Brown, 1996; Roberts & Wilson, 1999) and as effective as stretches of longer duration (Bandy & Irion, 1994). Nevertheless this difference in repetition did not have any impact on the incidence

of injuries. We could not be able to draw conclusions as to whether stretching does not have any effect in injury prevention because these studies had some limitations. In addition these are the only studies which were found during the search of published studies in the last decade.

Outcome used

The comparison of the two cohort studies was difficult, although both used stretching of hamstring muscles as intervention, because they used different outcomes: overuse injuries (Harting, & Hederson, 1999) versus hamstring muscle strain (Arnason et al., 2008). If the first study would have identified the occurrence of hamstring strain separately, we would be able to compare the incidence of hamstring injuries in both studies. Similarly, outcomes used in the two RCTs were different. The primary concern of researchers in the first study was selected six lower leg injuries (Pope et al., 1998) while soft tissue injuries were of concern in the second study (Pope et al., 2000). Lack of harmony in these studies in terms of outcome show the need for many studies aiming at reducing selected types of injuries.

Methodological quality

The results of Arnason et al. (2008) study might have been influenced by the extended exposure time during training and matches, the physical demands of the game as well as lack of close follow up on how stretching exercises were performed because the study had an extended period of time. The occurrence of injuries and the exposure time was reported by the physical therapist of each team which rendered impossible to blind the assessor. Methodologically, the results of the two cohort studies are difficult to compare since the military side was followed up over a period of 12 weeks and the elite athletes over a period of 28 weeks (one soccer season). Another reason is that soccer may

be classified as a high intensity and contact game compared to the exercises performed by military recruits.

One of the cohort studies which found that stretching might prevent injury is small and of lower methodological quality than the other cohort study which concluded negatively as to the effect of stretching in injury reduction. The two contradicting cohort studies are also of lower methodological quality compared to the two RCTs which did not provide evidence of the protective effect of stretching. Furthermore, the two RCTs were found to have some limitations such as lack of the use of statistical power (Pope et al., 1998), loss of follow up (Pope et al., 1998; Pope et al., 2000), and withdrawal not mentioned (Pope et al., 1998). One of them concluded that on average about 100 people would stretch for 12 weeks to prevent one injury and the average subject would need to stretch for 23 years to prevent one injury (Pope et al., 2000). From this, it is obvious that some studies could not find a worthwhile effect of stretching on the reduction of injuries when conducted for a short period of time. Therefore, there is a need of many months or years longitudinal studies to determine the significant effect of stretching in the reduction of injuries.

Conclusion

This systematic review find strong suggestion that muscle stretching before exercise does not reduce the risk of injuries. These conclusions are consistent with other reviews on the effect of stretching in injury prevention. Due to the selection criteria of relevant studies, this review found few studies. Comparison was difficult because of the variation in the definition of injury, designs, study population and outcome measures used. In addition, not enough research has been done to draw a definite conclusion on the effect of stretching

in injury prevention among either military population or other people engaging in physical activities and sport.

There is a need for carefully designed control trials in this field to shed light on the possible interventions for the prevention of injuries in sports with specific emphasis on stretching. Challenges that may be faced include the difficulty to randomize a greater numbers of athletes with a close follow up, controlled compliance as well as concealment, blindness and better statistical analysis. This would be important as there is an increase in number of athletes and growing recognition that all people need to increase their physical activity levels to improve their fitness for a better health and subsequent better quality of life.

Footnotes

Ethical approval

This is a systematic review therefore ethical issues were not applicable.

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Conflict of interest

The authors declare that no conflict of interest exists.

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