|  |
| --- |
| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

|  |
| --- |
| **In collegiate football players, are dynamic stretching programs effective in preventing hamstring strains/pulls?** |

**AUTHOR**

|  |  |  |  |
| --- | --- | --- | --- |
| **Prepared by** | Kip Stromberg, ATC, SPT | **Date** | 12/3/2016 |
| **Email address** | kip\_stromberg@med.unc.edu |

**CLINICAL SCENARIO**

|  |
| --- |
| An injury common in athletics is seen when an athlete comes up limping from pulling their hamstring while competing in sports such as football or rugby. This is a topic that is commonly talked about in the sports media and brings curiousity to what the best preventative intervention would be for this population. These injuries normally sideline athletes for many weeks. As physical therapists, if possible, an attempt should be made to prevent injury from happening in the first place. In the outpatient setting, these types of injuries are seen, after they happen, all the time. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

|  |
| --- |
| Ten studies were found that met the inclusion and exclusion criteria. These studies included six systematic reviews, one randomized controlled trial, two cohort studies, and one cross-sectional retrospective study. Three studies were selected which provided the best quality evidence, in answering the specific clinical question, which showed:* There is currently insufficient evidence to show whether preventative interventions are effective in reducing the number of hamstring injuries in sports which have a high incidence of hamstring injury.
* The evidence is mixed in whether static stretching decreases the incidence of hamstring injuries in football codes. There are limited numbers of RCTs that have been done in researching this area of study.
* Active stretching has been shown to improve and maintain hamstring range of motion greater than static stretching. Whether the improved range of motion decreases the incidence of injury hasn’t been sufficiently proven.
* Future Research should be focused on conducting high quality RCTs to show the relationship between dynamic (active) stretching and prevention of hamstring injuries. Many studies have been conducted using low-moderate level evidence for static stretching, but not specifically for dynamic stretching.
 |

**CLINICAL BOTTOM LINE**

|  |
| --- |
| When working with patients that compete in activities which have a high-risk for hamstring injuries, the evidence is mixed on the value of using a dynamic stretching program. In research, compliance has been a big problem in stretching programs. As clinicians, this is something that needs to be addressed throughout treatment. Some studies have shown static stretching reducing hamstring injuries and others have shown to have no effect, but the studies showing this haven’t been high quality studies. Currently, dynamic stretching hasn’t been researched enough, in regards to hamstring injury prevention, to recommend. Until higher quality studies are performed, best clinical judgement is recommended in using dynamic stretching as an intervention.  |

|  |
| --- |
| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

|  |
| --- |
| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Collegiate Football PlayersCollege Football PlayersCollegiate Football AthletesCollege Football AthletesUniversity Football PlayersUniversity Football AthletesVarsity Football AthletesVarsity Football Players | Dynamic Stretching | N/A | Prevention Hamstring StrainHamstring InjuryHamstring Pull |

**Final search strategy:**

SPORTDiscus with Full Text

1. Prevention AND Hamstring
2. Stretch OR stretching OR “dynamic stretching” OR “dynamic stretch”
3. #1 AND #2

|  |  |  |
| --- | --- | --- |
| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed****Cochrane****SPORTDiscus with Full Text**  | **40****34****99** | **N/A** |

## INCLUSION and EXCLUSION CRITERIA

|  |
| --- |
| **Inclusion Criteria** |
| * Systematic Reviews, Meta-Analysis, RCTs, controlled trials, uncontrolled trials, cohort studies, or retrospective studies
* Published in English
* Studied specifically hamstring injuries
* Studied stretching (dynamic or static or ballistic)
 |
| **Exclusion Criteria** |
| * Case series or case studies
* Abstracts, conference proceedings, letters to the editor, dissertations, narrative reviews
 |

**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**1–10

|  |  |  |  |
| --- | --- | --- | --- |
| **Author (Year)** | **Study quality score** | **Level of Evidence** | **Study design** |
| **Rogan, S (2013)**1 | **9/11 (AMSTAR)** | **2a** | **Systematic Review of Nonrandomized Controlled Trials** |
| **Small, K (2008)**2 | **8/11 (AMSTAR)** | **1b** | **Systematic Review of RCTs and Controlled Clinical Trials** |
| **Goldman, EF (2010)**3 | **11/11 (AMSTAR)** | **1a** | **Systematic Review of RCTs and Quasi-randomized Controlled Trials** |
| **Meroni, R (2010)**4 | **6/11 (PEDro)** | **1b** | **RCT** |
| **Hadjimichael, AH (2016)**5 | **6/11 (AMSTAR)** | **1a** | **Systematic Review of RCTs** |
| **Yeung, SS (2011)**6 | **11/11 (AMSTAR)** | **1a** | **Systematic Review of RCTs and Quasi-randomized Controlled Trials** |
| **Makaruk, B (2009)**7 | **14/29 (Downs and Black)** | **3** | **Cohort Study** |
| **Thacker, S (2004)**8 | **9/11 (AMSTAR)** | **1b** | **Systematic Review of RCTs and Cohort Studies** |
| **Brooks, J (2006)**9 | **17/29 (Downs and Black)** | **3** | **Cohort Study** |
| **Newsham-West, R (2009)**10 | **11/29 (Downs and Black)** | **3** | **Cross-sectional Retrospective Study** |

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

The reasons these three articles were selected is because the Goldman article was the highest quality of evidence of the many articles, the Rogan article was another high quality systematic review that specifically addressed the Football population and static stretching, and the Meroni article is a good RCT that compares dynamic (active) and static stretching. These three articles are the best evidence in addressing specifically the above clinical question. While there are four other systematic reviews that were found, they all have similar findings as Goldman et al. which is why they weren’t included in the 3 ‘best’ choices.

|  |
| --- |
| * Goldman E, Jones D. Interventions for preventing hamstring injuries (Review). *Physiotherapy*. 2011;97(2):91-99. doi:10.1002/14651858.CD006782.pub2.www.cochranelibrary.com.
* Rogan S, Wüst D, Schwitter T, Schmidtbleicher D. Static stretching of the hamstring muscle for injury prevention in football codes: A systematic review. *Asian J Sports Med*. 2013;4(1):1-9.
* Meroni R, Cerri CG, Lanzarini C, et al. Comparison of active stretching technique and static stretching technique on hamstring flexibility. *Clin J Sport Med*. 2010;20(1):8-14. doi:10.1097/JSM.0b013e3181c96722.
 |

**SUMMARY OF BEST EVIDENCE**

1. **Description and appraisal of “Interventions for preventing hamstring injuries” by Elliot F Goldman and Diana E Jones, 2010**

|  |
| --- |
| **Aim/Objective of the Study/Systematic Review:** |
| The objective of the systematic review was to examine the evidence for the effectiveness of interventions in preventing hamstring injuries. |
| **Study Design** |
| Search StrategyCochrane Bone, Joint, and Muscle Trauma Group Specialised Register; the Cochrane Central Register of Controlled Trials; MEDLINE; EMBASE; CINAHL; SPORTDiscus; AMED; PEDro; and reference lists were searched. Current controlled trials and the UK NRR Archive were also searched with no language restrictions being applied. Experts in the field and institutions were contacted to ientify theses and unpublished studies. Any intervention, or programme, for the prevention of hamstring injuries was included (stretching, strengthening, exercise to correct movement, manual therapies, neuromuscular strategies, educational awareness, general intervention). Selection CriteriaTrials were included that involved physically active patients of either gender from adolescence to adults of any age who were at an increased risk of incurring a hamstring injury. Any intervention that was specifically for the preventing of hamstring injuries was included in the review. A distinction was made for patients with and without a history of hamstring injury. Trials that focused on interventions for athletes with existing lower-limb injuries were excluded. Children under the age of 10 were also excluded. MethodsThis systematic review included randomised controlled trials and quasi-randomised controlled trials in which prevention strategies were compared against each other or against a control group.AllocationOut of the seven studies, four provided sufficient details in regards to method of randomisation. Only two of the seven studies had adequate allocation concealment. The other five studies had insufficient information to know if allocation was concealed. BlindingFour of the seven studies reported assessor blinding, but was only assured in two of those studies.  |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| All of the studies included were working predominantly with younger adults who regularly participated in sporting activities. The interventions applied were in field/court sports (football, Australian rules football, high school basketball, and recreational running). |
| **Participants** |
| There were 7 studies (6 published and 1 unpublished) that were included in this systematic review. Overall, there were a total of 1919 participants included for the review. 5 of the studies included only male participants, one had all females, and one had similar amounts of males and females. The average age of the trial participants in five of the studies was from 20-26 years of age. One study included only participants from 12-18 years of age and the other looked at adult civil servants which was an older population. Two studies excluded participants who had any injury at the time of the study, another excluded any participants that had an injury within the last six months that prevented full participation, and two studies excluded participants with a history of chronic hamstring injuries. All of the studies used a convenience sample to recruit their participants. |
| **Intervention Investigated** |
| *Control* |
| All of the studies included had control groups. The participants performed the normal training for the specific sport and no additional interventions (compared to the intervention group). The control groups participated in the same activities as the experimental group without the preventative interventions including a strengthening protocol, manual therapy, proprioceptive training, or warmup/cool down and stretching protocol. |
| *Experimental* |
| The experiment groups for each study included the normal training routines for each team (the same as performed by the control group) and additional preventative interventions including a strengthening protocol, manual therapy, proprioceptive training, or warmup/cool down and stretching protocol. The timeframe of the interventions ranged from 10 weeks (16 sessions) to 30 weeks (15 sessions).  |
| **Outcome Measures** (Primary and Secondary) |
| Primary outcome for all of the included studies was the occurrence of hamstring injury defined by a clinical physical assessment (diagnosis made by medical personnel, physical therapists, and orthopaedic surgeons). The incidence was included regardless of grade, site, and chronicity. The definition of injury was similar for five of the seven studies which was: “that which occurred during scheduled football/basketball matches or practices and caused the player to, at least, miss the next game or practice session” (pg. 7.). One of the included studies used a separate definition of injury which was:”sudden onset posterior thigh pain, tenderness on palpation, with or without pain on stretch of the hamstring muscles; and with or without pain on contraction of the hamstring muscles”(pg. 7). Yet another definition in one study was: ”that causing the participant to stop running, being unable to run on the next occasion, being unable to work the next day, needing medical attention, or suffering from pain or stiffness during 10 subsequent days while running” (pg. 7). Secondary outcomes, when included, were compliance, severity of injury, adverse effects, incidents of all lower-extremity injuries, and measures of service utilization. |
| **Main Findings** |
| In synthesizing the data, the authors used a fixed-model for studies that were statistically homogenous and used a random-effects model (or the results were not pooled) for studies that were statistically heterogenous. Meta-analyses were performed when studies were sufficiently clinically homogenous. Strengthening Protocol (3 studies)Pooled data from the three trials showed no statictically significant difference between participants that had sustained a hamstring injury between the intervention and control groups on incidence of hamstring injuries (RR 0.83, 95% CI 0.26 to 2.65; I² = 62%). This data was pooled on an exploratory basis. One study found a significant benefit to strength training (RR 0.30, 95% CI 0.10 to 0.88). But, the control rate of mostly minor hamstring injuries was unusually high (67%).Gabbe 2006 found no significant benefit of strength training (RR 1.16, 95% 0.48 to 2.83).Engebretsen 2008 found no evidence of benefit for hamstring strengthening (RR 2.71; 95% CI 0.35 to 20.79).Manual Therapy (1 study)The intervention group had fewer people who had sustained hamstring injuries than the control group, but not to statistical significance (1/28 versus 5/29, RR 0.21, 95% CI 0.03 to 1.66). Fewer participants in the intervention group sustained lower limb injuries than in the control group. The findings were statistically significant (RR 0.13, 95% CI 0.02 to 0.97).There was also found a positive statistical change for the intervention group in current and overall low back pain. Proprioceptive Training (2 studies)Pooled data from two studies showed that neither study found statistical significance between the control group and the intervention group (Emery 2007: RR 0.28, 95%CI 0.02 to 3.35; Söderman 2000: RR 0.53, 95% CI 0.17 to 1.63).This study was looking at all lower limb injuries, not specifically hamstring injuries.Warmup/Cool-Down and Stretching (1 study)There was no significant difference found between the intervention and control groups of recorded lower limb injuries (RR 1.21, 95%CI 0.69 to 2.11).Both groups ended up having an equal amount of hamstring injuries (3).  |
| **Original Authors’ Conclusions** |
| There is currently insufficient evidence from randomized controlled trials to conclude whether interventions are effective in preventing hamstring injuries from occurring in athletes participating in activities that have a high hamstring injury risk. There are some findings that manual therapy could be effective, but those findings need to be further researched. |
| **Critical Appraisal** |
| **Validity**[Identify the strengths and limitations of the study, including potential sources of bias. Comment on the overall methodological quality (including the score) as you determined from your assessment of the article. Comment on anything you believe was missing in the paper.] |
| The AMSTAR score for this study was 11/11 Priori design provided: yes; duplicate study selection and data extraction: yes; comprehensive literature search: yes; status of publication used as an inclusion criterion: yes; list of studies provided: yes; characteristics of the included studies provided: yes; scientific quality of those studies assessed and documented: yes; scientific quality used appropriately: yes; methods to combine the findings appropriate: yes; likelihood of publication bias assessed: yes; conflict of interest included: yes.Randomized and quasi-randomized controlled trials were only included making the study less susceptible to selection bias. Intention-to-treat analysis was possible for four of the seven studies.The authors did a great job of analysing the studies and checking power and effect for the individual studies. They also did a great job of listing the possible biases (detection bias, selection bias, etc.). Another key limitation, identified by the authors, was the lack of data/studies specific to hamstring injuries. There were more studies that looked at leg injuries, which I believe could have been used in their inclusion criteria. In three of the seven studies there were problems with follow-up and many of the studies listed compliance as a problem. This definitely affected the results of the review due to the low quality of some of the studies. |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| The authors did a great job of sharing the current research available and showing how studies specifically looking at hamstring injuries are few in number. Clearly, there isn’t enough quality evidence to conclude whether interventions can help to prevent hamstring injuries from occurring. In the studies included, there were a lot of confounding variables which could have affected the results (lack of follow-up, low compliance, etc.). There might be interventions that are effective in preventing hamstring injuries, but high quality research hasn’t been done to show the effectivenees of those interventions. There needs to be future research to know the real effect of the different interventions. |

**(2) Description and appraisal of “Static Stretching of the Hamstring Juscle for Injury Prevention in Football Codes: a Systematic Review” by Slavko Rogan, Dirk Wust, Thomas Schwitter, and Dietmar Schmidtbleicher, 2013**

|  |
| --- |
| **Aim/Objective of the Study/Systematic Review:** |
| The objective of the systematic review is to use currently available evidence to evaluate the effects of static stretching as a preventative intervention of hamstring injuries in football codes.  |
| **Study Design** |
| Search StrategyA literature search was performed using the following databases: PubMed, Cochrane Register of Controlled Trials, PEDro, Web of Science, and BispDatenbank. The Authors also searched the unpublished International Clinical Trials Registry Platform of the World Health Organization. After all of these searches were performed, a manual search was performed using the reference lists of the retrieved publications. Selection CriteriaArticles were included if they placed no emphasis on gender, had no age restrictions, the participants had no physical limitations, were randomized of nonrandomized controlled trials from the last 20 years, and were published or unpublished. MethodsThis systematic review included randomised controlled trials and quasi-randomised controlled trials over the last 20 years which looked into static stretching and prevention of hamstring injuries. If the full text couldn’t be found in the database searched, they were obtained via email from the authors. Due to unavailable data, a meta-analysis was not performed. AllocationNone of the studies included had adequately investigated the allocation concealment. The group classification of the subjects and the investigators was also found to be predictable.BlindingNone of the included studies reported blinding. The authors report the reason for not blinding being the need to pass on the information to the examiner from the medical department concerning the hamstring injuries.  |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| Each study included followed 60 different football teams of differing football codes. These studies were performed in the field. Specifics of each study setting were not included in the review.  |
| **Participants** |
| There were originally 35 studies selected. 14 of those studies didn’t meet inclusion criteria, 9 additional studies were found to be not relevant, and 8 were excluded due to not addressing hamstring injuries or football codes. 4 articles were included in the systematic review. The studies were from Australia, England, Iceland, Sweden, and the United States. The total sample the studies covered was 265 football players and 60 football teams. The studies were published between 1999 and 2008. |
| **Intervention Investigated** |
| *Control* |
| Only one study mentioned having a control group. The authors of the systematic review made no mention of a control group for the other three studies included.  |
| *Experimental* |
| All four of the studies included had an active static stretching programme. One of the studies added interventions including PNF, anaerobic training, and sport specific training. Another study performed flexibility training using active static stretching during football sessions. The subjects also performed strength training and endurance training. The time frame for the studies ranged from two to four years. The stretching exercise duration for all of the studies generally was for ~15-30 seconds which was repeated at least three times per leg. The subjects performed these exercises 3-5 times a week.  |
| **Outcome Measures** (Primary and Secondary) |
| Hamstring injuries were the primary outcome measure and they were calssifed into three grades which included minor injury with complete but painful contraction of the muscle (grade I), moderate injury with partial rupture of the muscle and abnormal contraction (grade II), and complete rupture of the muscle with impossible contraction (grade III). Games missed was also an included outcome measure if it was due to injures and posterior leg pain with direct contact leg injuires being excluded. To be considered injured, the athlete had to have the impairment for at least one day. The injuries were reported and diagnosed by medical professionals including doctors, MRI radiologists, medical staff, or coaches. The incidence was reported by medical professionals through a clinical examination.  |
| **Main Findings** |
| Two of the four included studies found static stretching programs to reduce lower extremity muscle injuries. One found that muscle and tendon strains decrease by about 48% (p<0.05). The other found that flexibility training correlates with a decreased injury rate (p=0.01). One of the studies concluded that it was unclear whether static stretching could prevent hamstring injuries, but reported hamstring strain incidence decrease in matches (p=0.01). Lastly, one study concluded that hamstring flexibility training had no effect on risk of injury for football players (p=0.2).  |
| **Original Authors’ Conclusions** |
| The authors concluded that there is currently not enough high quality evidence to make any conclusions on the effectiveness of static stretching on hamstring injury prevention. They also found that studies are diverse in their intervention duration and compliance increasing the chance of biases.  |
| **Critical Appraisal** |
| **Validity**[Identify the strengths and limitations of the study, including potential sources of bias. Comment on the overall methodological quality (including the score) as you determined from your assessment of the article. Comment on anything you believe was missing in the paper.] |
| AMSTAR score of 9/11 Priori design provided: yes; duplicate study selection and data extraction: yes; comprehensive literature search: yes; status of publication used as an inclusion criterion: yes; list of studies provided: no; characteristics of the included studies provided: yes; scientific quality of those studies assessed and documented: yes; scientific quality used appropriately: yes; methods to combine the findings appropriate: yes; likelihood of publication bias assessed: no; conflict of interest included: yes.The author’s didn’t include a list of the excluded articles which would have been helpful in understanding the reason for them being excluded. There were no RCTs included in the study that met the inclusion criteria. There was also a lot of diversity between studies in the protocol that was being tested. This makes it hard to know if the stretching protocol was the reason for decreased injury incidence. There also was limited information given about each study included in the systematic review.  |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| There is currently mixed evidence in the effectiveness of static stretching on hamstring injuries. The main limitation of the systematic review was the lack of randomized controlled trials that met the inclusion criteria. There were many confounding variables between studies (interventions performed at different times, additional interventions along with stretching, differing exercise durations, etc.). While it might be more difficult to perform, more high quality RCTs need to be performed to truly understand the effect of static stretching on the prevention of hamstring injuries. |

**(3) Description and appraisal of “Comparison of Active Stretching Technique and Static Stretching Technique on Hamstring Flexibility” by Roberto Meroni, Cesare Giuseppe Cerri, Carlo Lanzarini, Guido Barindelli, Giancesare Della Morte, Viviana Gessaga, Gian Carlo Cesana, and Giovanni De Vito, 2010**

|  |
| --- |
| **Aim/Objective of the Study/Systematic Review:** |
| The objective of the randomized controlled trial is to compare a passive and an active stretching technique to determine which one would produce and maintain the greatest gain in hamstring flexibility.  |
| **Study Design** |
| The randomized controlled trial consisted of a 6 week stretching program where 50 subjects were randomly assigned to one of two different intervention groups (active stretching and static stretching). None of the subjects or assessors were blinded to the intervention. The subjects were assessed for active knee extension range of motion and finger-ground distance at baseline, 3-weeks, 6-weeks, and 4-weeks post intervention. All subjects were assessed by the same assessor. Each participant was given individual instruction during a 1-hour training session about group assignment and stretching protocol. Each subject also received written instructions with drawings on the stretching procedures and were monitored during the first session by the examiner to ensure proper performance. No control group was used based off of prior research that showed stretching was more effective than the passage of time.  |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| The setting for the study was in an institutional clinic for the instruction and testing. All stretching protocols (except the original session) were performed wherever met the participants needs.  |
| **Participants** |
| 50 healthy university students, family members, and friends met the criteria and entered the study (21 women, 29 men, mean age 23.44 years). 65 subjects volunteered and 50 were selected to participate (convenience sample). The participants were eligible if they had no history of knee, hip or spinal conditions that required medical intervention or any other condifition that could have affected hamstring length or ability to perform the exercises in the study. The subjects qualified for the study if they had a lack of hamstring flexibility which was defined as having less than 160 degrees of knee extension (measured with the femur held at 90 degrees of hip flexion). The participants were instructed to maintain their level of activity throughout the study. The authors found homogeneity between groups at baseline for hamstring tightness, age, gender, height, weight, MBI, sport practice, and stretching habits. A total of 17 subjects were excluded due to not performing the required 75% of training sessions.  |
| **Intervention Investigated** |
| *Experimental (Active Stretch)* |
| The active stretch group performed 4 repetitions of each leg, twice a day for four days a week. For each repetition the subjects were in a sitting position where they were asked to keep their pelvis in a neutral position and extend one knee to the point of discomfort or tightness in the hamstring muscles or the feeling of loosness in the neutral pelvic position. This position was maintained for 30 seconds. The authors discuss how this technique was based on reciprocal inhibition of the agonistic and antagonistic muscles. Each active stretching session lasted 8 minutes. The training was all unsupervised.  |
| *Experimental (Static Stretch)* |
| The static stretch group performed two exercises which included standing erect with a foot planted and placed directly forward without hip rotation. The posterior calcaneal aspect of the contralateral limb was placed on a chair or step with the toes of the foot directed toward the celing without rotation of the hips. The knee remains fully extended throughout the exercise. The subject flexed forward from the hip while maintaining a neutral spine and reaching the arms forward. They reached forward to the point of discomfort or tightness in the hamstrings. The position was then held for 30 seconds. The second exercise involved subjects being in a seated position on the ground with extending one knee and folding the other to the side. The subject kept their back straight and flexed forward slowly at the hip to the point of discomfort or tightness in the hamstrings with the knee fully extended. This was also held for 30 seconds. For each session and exercise they performed 3 repetitions for each leg, twice a day, and four days a week. Each static stretching session lasted 12 minutes. Again, the training was all unsupervised. |
| **Outcome Measures** (Primary and Secondary) |
| The primary outcome measure was the active knee extension range of motion test (AKER) and the secondary outcome measure was the finger ground distance test (FGD). Each participant was measured using both measures prior to group assignment. Both of these outcomes were measured in the clinic. The AKER test was performed using a standard goniometer with full circle protractors. The measurements were expressed to 1 decimal point. The AKER was performed with subjects on a sturdy surface and at a height that wouldn’t allow contact with the floor. Markers were placed on the greater trochanter, lateral femoral epicondyle, and lateral malleolus. Subjects were instructed to extend their knee until they reported discomfort or tightness in the hamstrings or couldn’t maintain pelvic neutral. Each subject had 3 practice trials and 3 test trails with the mean of the 3 test trials used for the calculations. The FGD was performed with the subjects standing on a stool which had a centimetre ruler. The subjects stood without shoes and feet slightly apart. The subjects were instructed to bend forward with their knees, arms, and fingers fully extended until they felt discomfort or tightness in the hamstrings. The vertical distance from the tip of the middle finger to the stool level was read. The subject performed 3 practice trials and 3 test trials. There was one examiner who collected all of the data.  |
| **Main Findings** |
| After 3 weeks, the active stretching group showed a mean improvement in AKER of 5.7 degrees compared to the static stretching group shawing a mean improvement of 3 degrees (p=0.015). After 6 weeks, the active stretching showed a mean improvement of 8.7 degrees compared to 5.3 degrees for the static stretching group (p=0.006). The FGD was consistent with the AKER results in that after 3 weeks the active stretching group showed a mean improvement of 6.2 cm compared to 3.7 cm mean improvement for the static stretching group (p=0.014). After 6 weeks, the active stretching group showed a mean improvement of 9.0 cm compared to a mean improvement of 6.5 cm for the static stretching group (p=0.009). Four weeks after the stretching intervention, 22 participants were reassessed and the active stretching group had maintained a mean improvement in AKER of 6.3 degrees compared to 0.1 degrees in the static stretching group (p=0.003). The FGD score after four weeks showed a maintained mean improvement in the active stretching group of 6.1 cm compared to a maintained mean improvement of 1.9 cm for the static stretching group (p=0.004).  |
| **Original Authors’ Conclusions** |
| Active and static stretching programs have been observed to improve range of motion and flexibility. Active stretching produces greater increases in active knee extension range of motion and was almost completely maintained 4 weeks after the end of the training period. Static stretching almost completely lost the gain in range of motion after 4 weeks. Active stretching is more time efficient and requires less compliance to improve flexibility.  |
| **Critical Appraisal** |
| **Validity**[Identify the strengths and limitations of the study, including potential sources of bias. Comment on the overall methodological quality (including the score) as you determined from your assessment of the article. Comment on anything you believe was missing in the paper.] |
| PEDro Scale score of 6/11 based on eligibility criteria: Yes;Random Allocation: Yes;Concealed Allocation: No;Baseline Comparison: Yes;Blind Subjects: No;Blind Therapist: No;Blind Assessors: No;>85% participant outcomes: No;Intention to treat analysis: Yes;Between group comparison: Yes;Point estimates and variability: Yes. The authors also discussed not achieving the required power due to small sample size. They also mentioned one of the main problems which was the unsupervised nature of the stretching protocols. There was a high drop out rate with only 66% of the participants completing the intervention portion of the study. It would have been beneficial for the participants to keep an exercise log to know the differences in level of activity. This could be a confounding variable. There also was a low sample size which underpowered the study.  |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| Active stretching of the hamstrings improves and maintains knee extension flexibility greater than static stretching. This study had a low response rate which didn’t provide enough power for the authors to make a definitive conclusion. There were many confounding factors in the study that could have effected the results, but both experimental groups were affected by those confounding variables. Of the two experimental interventions, active stretching is the better choice when wanting to improve range of motion or flexibility. The authors tested only healthy individuals, so these findings can only be generalized to this population.  |

**EVIDENCE SYNTHESIS AND IMPLICATIONS**

|  |
| --- |
| Implications for Clinical PracticeCurrently, there is not enough high quality evidence to recommend for or against the use of dynamic stretching for hamstring injury prevention. As Goldman et al3 discuss, their results for stretching protocols are in agreement with past systematic reviews that have been performed which show that, “no definitive conclusions could be drawn as to the value of stretching for reducing the risk of injury.” Many of the systematic reviews in this paper also discuss how there have been very few RCTs performed in looking into prevention strategies for hamstring injuries. The current research has been mixed in the effects of static stretching on injury prevention. For example, in the systematic review by Rogan et al1, they found that half of the studies included in the review concluded that static stretching can prevent injuries. The other half concluded that either it was unclear or static stretching hasn’t been shown to prevent injuries. Dynamic stretching has been shown to have greater improvements in range of motion compared to static stretching. It has also been shown to help maintain improved range of motion for at least 4 weeks post intervention.4 Dynamic stretching therefore would be a better choice for individuals that struggle with compliance. It could be used as part of a warm-up protocol for athletes competing in events with a high-risk for hamstring injuries. But, it is important to note that dynamic stretching hasn’t been researched enough to confidently recommend for or against its inception. Current best practice is to incorporate active stretching into treatment based on best clinical judgement. The National Strength and Conditioning Association recommend that, “dynamic stretches are increasingly the preferred method of stretching during warm-up.11” The argument could be made that because the literature is mixed in the effectiveness of static stretching that it hasn’t been shown to be effective in preventing injuries so there is no need to participate in the intervention. Better research will truly help us to know the value of stretching, dynamic stretching in particular. When looking specifically at college football players, this population hasn’t been specifically assessed. They were included in many studies, but not in isolation. Future research should focus on this specific population due to the incidence rate of hamstring injuries in college football. Future ResearchImplications from the studies included in this paper recommend future research focusing on adequately powered, high quality studies including RCTs. Research has been done on static stretching, strengthening, proprioceptive training, and manual therapy. Future research needs to continue to address these areas, but also look specifically into the potential of dynamic (active) stretching in preventing injuries. Stretching protocols need to be more standardized to get better results and avoid confounding factors. Rogan et al1 discuss in their systematic review how each of the studies examined had the stretching protocol performed at different times (during warm-up, during exercise, after exercise, etc.). Intervention diversity between the current research makes it difficult to know what interventions are best at preventing injuries. In the systematic review by Rogan et al1, only one of the four studies included in the review looked solely at static stretching and its role in injury prevention. All of the others included static stretching with other interventions. Studies currently have addressed athletes of many different age ranges and sport settings. Clearly, hamstring injuries are a concern based on the quantity of studies performed that look into the prevention of these injuries. While it is great that studies have been performed, quality studies are needed to understand the effectiveness of dynamic stretching in preventing hamstring injuries. Studies need to be performed that eliminate confounding variables (as best as possible), are adequately powered, and address solely dynamic stretching as a preventative intervention.  |

**REFERENCES**

[List all references cited in the CAT]

|  |
| --- |
| 1. Rogan S, Wüst D, Schwitter T, Schmidtbleicher D. Static stretching of the hamstring muscle for injury prevention in football codes: A systematic review. *Asian J Sports Med*. 2013;4(1):1-9.2. Small K, Mc Naughton L, Matthews M. A systematic review into the efficacy of static stretching as part of a warm-up for the prevention of exercise-related injury. *Res Sports Med*. 2008;16(3):213-231. doi:10.1080/15438620802310784.3. Goldman E, Jones D. Interventions for preventing hamstring injuries (Review). *Physiotherapy*. 2011;97(2):91-99. doi:10.1002/14651858.CD006782.pub2.www.cochranelibrary.com.4. Meroni R, Cerri CG, Lanzarini C, et al. Comparison of active stretching technique and static stretching technique on hamstring flexibility. *Clin J Sport Med*. 2010;20(1):8-14. doi:10.1097/JSM.0b013e3181c96722.5. Hadjimichael A, Apostolos S. Hamstring strains in football. Prevention and rehabilitation rules. Systematic review. *J Biol Exerc*. 2016;12(1):121-148.6. Yeung SS, Yeung EW, Gillespie LD. Interventions for preventing lower limb soft-tissue running injuries. *Cochrane Database Syst Rev*. 2011;(7):CD001256. doi:10.1002/14651858.CD001256.pub2.7. Makaruk B, Makaruk H. CHANGES TO FLEXIBILITY OF THE HAMSTRING IN SPRINTERS IN THE CONTEXT OF PREVENTION. *Polish J Sport Tour*. 2009;16(3):152-154. http://search.ebscohost.com.www.dbproxy.hu.nl/login.aspx?direct=true&db=s3h&AN=44724478&site=ehost-live\nhttp://ezproxy.spfldcol.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=44724478&site=ehost-live.8. Thacker SB, Gilchrist J, Stroup DF, Kimsey CD. The Impact of Stretching on Sports Injury Risk: A Systematic Review of the Literature. *Med Sci Sports Exerc*. 2004;36(3):371-378. doi:10.1249/01.MSS.0000117134.83018.F7.9. Brooks JHM, Fuller CW, Kemp SPT, Reddin DB. Incidence, Risk, and Prevention of Hamstring Muscle Injuries in Professional Rugby Union. *Am J Sports Med*. 2006;34(8):1297-1306. doi:10.1177/0363546505286022.10. Newsham-West R, Button C, Milburn PD, et al. Training habits and injuries of masters’ level football players: A preliminary report. *Phys Ther Sport*. 2009;10(2):63-66. doi:10.1016/j.ptsp.2009.01.002.11. Haff GG, Triplett NT, eds. *Essentials of Strength Training and Conditioning*. Fourth Edi. Human Kinetics; 2016. |