



METRO HEALTH

UNIVERSITY OF MICHIGAN HEALTH

Sports Medicine

Stretching: From Warm-up to Cool-down

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Potential other lecture titles:

- *The Case of the Disappearing Stretch* Sir Arthur Conan Doyle/Sherlock Holmes,
circa 1860
- “To stretch, or not to stretch: that is the question...” Prince Hamlet/William
Shakespeare, 1603

Objectives

- 1. To discuss types of stretching.
- 2. To determine whether and how stretching impacts injury rates.
- 3. To determine if stretching affects performance.
- 4. To align stretching with warming-up and cooling-down.
- 5. To be able to use current data to answer the question: “Doc/AT/PT....should I stretch, and how?”

Impact of Stretching on the Performance and Injury Risk of Long-Distance Runners

Baxter C *et al.* Research in Sports Med (2017) 25:1, 78-90.

- “Stretching has long been considered an integral part of the training routines for athletes and is used across all disciplines as a tool of preparation, performance enhancement and injury prevention. In recent years, however, it has been suggested that the tendency to incorporate stretching into the regimes of athletes was not based on science but assumption.”

Problems with research

- Different types of stretches
- Different types of warm ups

Stretching “Defined”

- Basically **stretching** is a form of physical exercise in which a specific **muscle** or tendon (or **muscle** group) is deliberately flexed or **stretched** in order to improve the **muscle's** felt elasticity and achieve comfortable **muscle** tone. The result is a feeling of increased **muscle** control, flexibility, and range of motion. (Quora)
- Exercises that **stretch** the **muscle** fibers with the aim to increase **muscle-tendon FLEXIBILITY**, improve **RANGE OF MOTION** or musculoskeletal function, and prevent injuries. (Reference MD)

What is flexibility?

- The total achievable excursion (within the limits of pain) of a body part through its range of motion (J Saal 1998).
 - Individually variable
 - Joint specific
 - Inherited characteristic that decreases with age
 - Varies by gender and ethnic group
 - Bears little relationship with body proportion or limb length
 - Can be modified through training
 - Flexibility for Runners. Jenkins J *et al.* Clin Sports Med (2010) 29, 365-377

Why is flexibility important (and is it)?

“too loose” ← “just right” → “too tight”

- Sport/activity specific?

Concepts

- Warm-up: a set of activities designed to prepare the body for exercise (raise heart rate and body/muscle temperature).
- Cool-down: a set of activities designed to safely allow resumption of normal life.
- Pre-performance stretching: stretching done prior to a specific practice or contest.
- Chronic/ongoing stretching: stretching done as a regular part of health maintenance—may be related to ongoing sport or activity.

Who said this:

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 - Gene Dykes, 70 year old sub 3 hour marathoner

What are we trying to achieve?

- “As long as you understand what you are trying to achieve and use the exercises that achieve this goal, it [what type of exercise you do] is not too important.”

Arthur Lydiard

- Typically two things:
 - Improved performance
 - Decreased injury risk

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- Typically two things:
 - Improved performance
 - Decreased injury risk
- Who here stretches? Warms up? How?

Warm Up

- “While warm up is considered to be essential for optimum performance, there is little scientific evidence supporting its effectiveness in many situations....While many studies have investigated the physiological responses to warm up, relatively few studies have reported changes in performance following warm up.”
 - Warm Up II: Performance Changes Following Active Warm Up and How to Structure the Warm Up. Bishop, D. Sports Med (2003) 33:7, 483-498.
- Although not limited to the warm up, some type of stretching is often a component.

Impact of Stretching on the Performance and Injury Risk of Long-Distance Runners (cont)

- Does stretching improve flexibility?
 - What is stretching: broad term used to describe an array of passive and active movements used to increase flexibility (ballistic, dynamic, static, passive with partner, contract-relax/muscle energy).
 - Research suggests simple static stretch when performed regularly over a minimum of 6 weeks will increase flexibility (Bandy & Iron, 1994; Thacker *et al.*, 2003).
- Do we care (is flexibility important)? →

Impact of Stretching on the Performance and Injury Risk of Long-Distance Runners (cont)

- Multiple studies suggest elite endurance runners are LESS flexible than non-elites.
 - Running economy is a key performance variable and is measured by the energy demand at a specified velocity (more efficient runners use less energy at a given pace than less efficient runners).
 - Endurance runners with lowest flexibility have most economical running styles.
 - Those with the gene COL5A1 (a gene associated with inflexibility) have a higher running economy.
 - Improves stability of the pelvic region when the foot hits the ground.
 - Suggested optimal range of flexibility—too loose or too tight can cause problems.

Impact of Stretching on the Performance and Injury Risk of Long-Distance Runners (cont)

- What about pre-performance stretching?
 - “Although stiffness has traditionally been considered a factor that has the potential to increase the risk of injury and inhibit athlete’s performance in the early stages of a race, it appears it is a desirable trait for long-distance runners....all reported that acute stretching before endurance-based events does not assist athletes performance and in fact can diminish it.”
- Ongoing/chronic/regular stretching?
 - No studies reported that running economy would either improve or decline from long-term stretching programs.

Impact of Stretching on the Performance and Injury Risk of Long-Distance Runners (cont)

- **DOMS (Delayed Onset Muscle Soreness)?**
 - Multiple studies show no variation of stretching has the ability to alter DOMS for an athlete of any discipline.
 - In a systematic review and meta-analysis (Torres R *et al.* Phys Ther in Sport (2012) 13: 101-114) showed therapeutic massage is the only intervention that had a positive effect on muscle soreness and function, although mean effect quite small. Inconclusive evidence to support cryotherapy, stretching and low-intensity exercise.

Impact of Stretching on the Performance and Injury Risk of Long-Distance Runners (cont)

- **Stretching and chronic injury:**
 - Majority of studies suggest that stretching has no impact on the risk of chronic injury in endurance runners.
 - Can increase the compliance of the muscle-tendon unit and may allow greater force production at longer muscle lengths which may be relevant to other sporting disciplines.
 - Can aid in the maintenance and promotion of range of motion in hip, knee and ankle joints after injury, and depends on what individuals are participating in and what the athlete is trying to achieve. “This highlights that the relationship between the effects of stretching and sporting activities generally is not clear and some athletes may benefit from incorporating chronic stretching into their routine from an injury risk standpoint.”

Does warming up prevent injury in sport?

The evidence from randomized controlled trials. Fradkin *et al.* J Sci Med Sport (2006) 9, 214-220.

- Studies from 1966-2005, 39 ID'd in initial search, five made final cut.
- Studies mix of age, gender, activities and warm up time (3-40 min).
- Team sports (HS American football and handball) studies showed subsets of injury reduction, running studies did not.
- American football—sprains and strains in third quarter lower after half-time warm up. No difference in others injuries or overall number of injuries. Handball showed reduction in both traumatic and overuse injuries.
- Recreational runners (16 weeks) and military recruits (12 weeks) no reduction.
- Three studies with reduction focused on increase body temp. Two which suggested warm up ineffective focused on stretching.
- “As each sport has its own unique qualities, it is possible that warming up may be a useful injury prevention tool for some sporting activities and not others.”

The effect of sports specific training on reducing the incidence of hamstring injuries in professional Australian Rules football players.

Verrall GM *et al.* Br J Sports Med (2005) 39, 363-368

- “An intervention program based on increased high intensity interval anaerobic training that more accurately reflected match playing conditions, stretching whilst the muscle was fatigued, and the implementation of sport specific training drills was implemented. This resulted in a significant reduction in the number of muscle strain injuries and consequently in the number of competition games missed in a group of Australian football players.”
- Key points: sports specific, match conditions, post-activity, type of injury.

Prevention of Running Injuries

Fields KB *et al.* Curr Sports Med Rep (2010) 9:3, 176-182

- Two large metaanalyses:
 - 12 major trials, 8806 runners: “The data were insufficient to suggest any benefit of stretching in preventing lower extremity running injuries.”
 - Comprehensive metaanalysis of articles spanning 1997 to 2002: concluded “no evidence for the reduction of injuries.”
- Reinforced findings of multiple smaller studies—some even suggested the stretching group had more injuries than control group.
- One study showed greater cardiovascular fitness was associated with lower injury risk, NOT flexibility.

Prevention of Running Injuries (cont)

- **Stretching for specific injuries/problems:**
 - Plantar fasciitis: prospective two year study showed 92% satisfaction at two years in those with plantar fasciitis.
 - Not all studies noted as positive results—some show increased flexibility in stretched muscles, but not necessarily pain relief or clinical functional improvement.
- **What about “warming up?”**
 - Fradkin article—runners generally not helped by warm up.
 - Another study with 1680 runners—warm up did not appear to be associated with lower injury risk.
 - Authors feel not “enough high-quality research to determine whether warm up helps prevent running injuries.”

Type of sport/activity and injury type important?

- Herman (2012) review looked at nine studies which included the following sports: soccer, basketball, volleyball, army recruits.
- “To provide the greatest potential for reduced lower limb injury rates, it is recommended that neuromuscular warm-up strategies incorporate stretching, strengthening, and balance exercises, sports-specific agility drills and landing techniques, and are completed for a duration of longer than three consecutive months at all training sessions.”

Type of sport/activity and injury type important?

- Multiple studies (Popp 2017, McHugh 2010, Small 2008, Behm 2011, Donaldson 2015, Brown 2008, Pappas 2017, Van Gelder 2011, Sporis 2011, Miranda 2015, Avloniti 2015, Escamilla 2016...) all suggest that the type of stretching or warm-up needs to be tailored to the sport or task at hand and that certain injury rates are more likely to be reduced (sprains and strains in particular).

Sport/activity specific?

- “After a 40-pitch bullpen session, IR and ER PROM and total rotational motion significantly decreased from prepitching measurements. After performing the two-out drill [short-duration stretching/calisthenics drill], IR and ER PROM and total rotational motion were restored back to their prepitching values, which may increase pitching performance and decrease the risk of shoulder and elbow injuries.”
 - Effects of a Short-Duration Stretching Drill After Pitching on Elbow and Shoulder Range of Motion in Professional Baseball Pitchers. Escamilla RF *et al.* AJSM (2017) 45:3, 692-700.
- Key points: sport specific and will it matter?

Sport/activity specific?

- Review of upper body warm-up studies (21 studies, 25 warm-up modes, 43 outcome factors—baseball, kayakers, paddlers, golf, tennis, American Football, javelin/shot/discus):
 - Warm-up swings with a standard weight baseball bat are most effective for enhancing bat speed.
 - Short-duration static stretching has no effect on power outcomes.
 - Dynamic stretching warm-up may be able to be performed without adverse performance effects.
 - A systematic review of the effects of upper body warm-up on performance and injury. McCrary JM *et al.* BR J Sports Med (2015) 49, 935-942.

What about post-event stretching (cool-down)?

- Not as much research/data on this topic.
- Most feel light activity to allow the heart rate and body temperature to return to normal is prudent, and that stretching, and in particular SS, is best done at this time. May lend to overall flexibility (chronic/ongoing stretching).
- According to Peck *et al.* in a 62 study review “static stretching and PNF stretching probably are reserved best for the period after activity, if used.”

The Effects of Stretching on Performance. *Curr Sports Med Rep* (2014) 13:3, 179-185.

Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a systematic review.

Behm *et al.* Appl Physiol Nutr Metab (2016) 41, 1-11.

- Multiple authors and multiple studies (125 SS, 48 DS, 11 PNF).
 - Injury rates in endurance or military training (overuse type injuries):
 - 2 benefit (reduced muscle injuries), 3 no benefit.
 - Sprint running-type sports:
 - Fewer muscle injuries in 5/5 with stretching.
 - Felt research indicates preactivity stretching beneficial in sports with sprint running component, but not in endurance based running activities with overuse type injuries.
 - Also noted “all forms of muscle stretching have been shown to provide a significant acute ROM benefit.” And while there was no overall reduction on all-cause injury, there may be a benefit in reducing acute muscle injuries with running, sprinting, or other repetitive contractions.

What about static v. dynamic stretching? (Behm)

- “Recent evidence suggests that sustained SS could impair subsequent performance (Shrier 2004; Behm and Chaouchi 2011; Kay and Blazevich 2012), and the perceptions regarding the benefits of SS in a preactivity routine have changed dramatically. Indeed current evidence indicates significant positive effects of dynamic forms of stretching (DS).”
- “Strong body of evidence supporting positive or neutral effects of dynamic stretching on subsequent muscular performance....[and DS] represents a more efficient modality than static stretching to be employed prior to subsequent muscular performance, and especially prior to explosive or high speed activities.”
 - Acute Effects of Dynamic Stretching on Muscle Flexibility and Performance: An Analysis of Current Literature. Opplert and Babault. Sports Med (2018) 48, 299-325.
- Case closed...or is it?

Psychological Effects?

- “The negative psychological impact of altering precompetition routine may outweigh any possible benefit associated with removing SS [static stretching] from their warm-up.”
 - The Effects of Static Stretching on Running Economy and Endurance Performance in Female Distance Runners During Treadmill Running. Mojock CD *et al.* J Strength Cond Res (2011) 25:8, 2170-2176.
- “Athletes have accustomed themselves to include stretching their warm-up routine. Thus if someone acutely removes or reduces stretching from his or her usual warm-up routine, this could lead to a reverse effect, as the athlete may feel unable to perform maximally without their ‘habitual routine.’”
 - Effects of Static and Dynamic Stretching on Sprint and Jump Performance in Boys and Girls. Paradisis *et al.* J Strength Cond Res (2014) 28:1, 154-160.

Certain sports/activities/positions:

- Gymnasts
- Hockey goalies
- Hurdlers

Static Stretching

- “There is preliminary evidence that static stretching may have a positive effect on preventing musculotendinous injuries.”
 - A Systemic Review Into the Efficacy of Static Stretching as Part of a Warm-Up for the Prevention of Exercise-Related Injury. Small *et al.* Res in Sports Med (2008) 16, 213-231.

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- And then there’s this→

No Effect of Muscle Stretching within a Full Dynamic Warm-up on Athletic Performance

Blazevich AJ *et al.* Med Sci Sports Exerc (2018) 50:6, 1258-1266.

- Low-intensity warm-up (3min jog @50% PE/5s high knees/butt kicks)
 - 5s static stretch
 - 30s static stretch
 - 5 rep dynamic w/u
 - No-stretch
- High-intensity warm-up (2min jog @60% PE/5s high knees/butt kicks)
 - Test circuits @ 60/80/100% exertion
 - 7 min rest
 - Flexibility (sit and reach)
 - Circuit (3m running vert jump, squat/countermovement/drop jumps, agility, 20m sprint)

No Effect of Muscle Stretching within a Full Dynamic Warm-up on Athletic Performance (cont)

- **Participant Bias:**
 - 18/20 felt dynamic warm-up would be the most likely beneficial pretesting routine. Two felt the 30s static stretch would be best.
 - 15/20 thought no stretch would be least beneficial, and five felt 30s static stretch would be least.
 - Most common order was DYN > 5S > 30S > NS.
- **Findings:** no statistical differences in any of the circuit tests or flexibility among any of the stretching protocols.

No Effect of Muscle Stretching within a Full Dynamic Warm-up on Athletic Performance (cont)

- “The main finding of the present study was that the inclusion of a period of either static (passive) or dynamic stretching within a comprehensive preexercise physical preparation routine (i.e., a “warm-up”) did not detectably influence flexibility or maximal vertical jump, sprint running acceleration, or change of direction (T agility) test performances compared with NS control condition.”
- Although participant beliefs “did not meaningfully influence test performances in the present study, participants might theoretically perform better in a competitive sport environment when their perceptions of preparedness are higher.”

No Effect of Muscle Stretching within a Full Dynamic Warm-up on Athletic Performance (cont)

- Similar warm-up periods “have been endorsed for the improvement of sports performance and reduction in musculoskeletal injury risk, even when static stretching is incorporated.” (Warm-Up and Stretching in the Prevention of Muscular Injury. Woods K *et al.* Sports Med (2007) 37:12, 1089-1099 and The Effectiveness of Neuromuscular Warm-Up Strategies, That Require no Additional Equipment, for Preventing Lower Limb Injuries During Sports Participation: a Systematic Review. Herman K *et al.* BMC Medicine (2012) 10:75, 1-12).
- Short- or moderate-duration static stretching should be allowed or even promoted, as part of the warm-up routine before sports participation.
- Dynamic stretching may also be incorporated although no data currently exist documenting the influence of dynamic stretching on injury risk.

So what does this all mean?

- **Light/recreational activities:**
 - Warm-up may consist of easing into the activity.
 - No stretching or specific warm-up needed.
- **Moderate to high intensity workouts:**
 - 10-20 min light aerobic exercise.
 - 5-6 min stretching related to the sport or activity—if SS keep to 30s or less.
 - 5 min higher intensity aerobic activity as move into workout.
 - This can be shortened to 10 min light and 5 min higher intensity without stretching for endurance events, but should include stretching for sprint-type sports/activities.

So what does this all mean?

- **Competition:**
 - Same as high intensity, but make sure sport/activity related. If SS allow longer time post stretch.
 - Target muscle groups known to be at risk for particular sport or activity.
 - Bench players will need some warm-up after initial warm-up.
- **Chronic/ongoing stretching:**
 - If injured/recovering or tight in a specific area.
 - Certain skills/activities/positions where flexibility as at a premium.
- Don't change anything or change gradually—warm-up will be an individualized process.
- Cool-down for 5 min minimum to lower HR and body temperature.

Thank-you!

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