Questioning the Use of Static Stretching Before and After Athletic Activities

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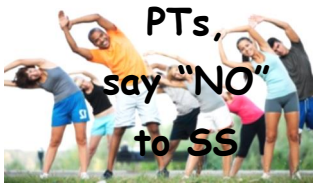
Static stretching (SS) is performed by athletes and non-athletes, and is often strongly encouraged by personal trainers and coaches. SS is also frequently prescribed by health care providers such as physical therapists following various musculoskeletal injuries. The standard justifications given for doing SS on a regular basis is that it i) helps improve muscular and tendon flexibility ii) improves athletic performance iii) reduces post exercises soreness and most importantly, SS allegedly iv) reduces the risk of future injuries.

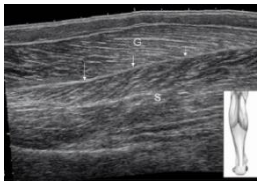


The purpose of this bound-to-be controversial paper is to demonstrate how the cumulative evidence to date in fact disproves all the above-mentioned hypothesized benefits of SS. To help clinicians make the transition away from SS focused interventions, this paper will also provide alternative evidence-based options to SS.

Assumption #1: The current evidence supports that SS lengthens muscles and tendons.

☐ True ☑ False

There is certainly evidence that SS improves flexibility and range of motion (ROM), but very often the changes appear to be short-lasting (i.e. 30 minutes) (de Weijer et al 2003, Ford et al 2007). A systematic literature review on hamstring stretching concludes that several weeks of SS does result in improvements in hamstring flexibility and increases in ROM (Decoster et al 2005). The automatic assumption may be that the improvements in ROM are obviously a result of increased length of the muscle fibers and tendons. Questioning the theory that muscle fibers actually lengthen with SS, a study not only measured changes in ROM, but actually analyzed the effects of a 6 week SS program on gastrocnemius muscle and Achilles tendon fiber length (Konrad et al 2014). Although significant improvements in ROM were made following SS, fascicle length and tendon junction displacements as measured with ultrasound were unaltered. The authors hypothesize that the improvements in ROM could not therefore be explained by actual structural changes in the muscle and tendon units but the increase in flexibility may be due to adaptations of nociceptive nerve endings allowing for increased stretch tolerance.



Perhaps dancers, gymnasts and Yoga practitioners who stretch regularly, can gradually stretch further because either they have less pain while they stretch or they simply can tolerate more pain. A number of studies have proposed that the increased ROM following SS may be due to alterations in stretch sensation and tolerance, rather than alterations in actual muscle extensibility (Weppler & Magnusson 2010).

A clear example that muscle length is not necessarily the limiting factor to ROM is that

compared to being awake, a person under anesthetic can be stretched much further; obviously anesthesia has no effect on muscle or tendon fiber length. Similar to anaesthesia, at least in the short term, SS may have little effect on muscle, tendon and fascicle length.

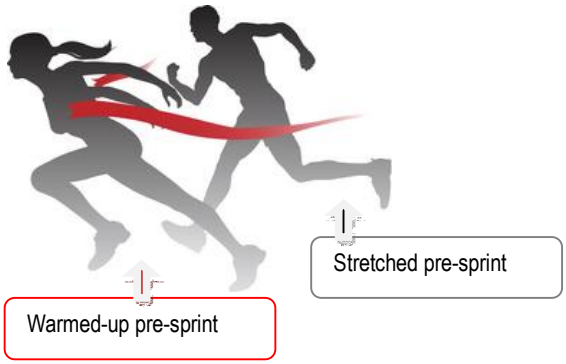
Other options for lengthening muscles and tendons

Studies have demonstrated that eccentric strength training produces changes to the mechanical properties of the muscles and tendons resulting in increased fascicle length and improved flexibility (Mahieu et al 2008, Duclay et al 2009).

Clinical Conclusion #1: Based on the available evidence we can safely conclude that SS does improve joint and muscle flexibility, however the flexibility gained may not always be from actual tissue fiber lengthening. If muscle fiber lengthening is required, eccentric strengthening exercises to end of range may be more effective.

Assumption #2: The current evidence supports that SS improves athletic performance.
☐ True ☑ False

To date, SS has never been shown to actually improve athletic performance, yet it is almost preached by many as factual. Ironically studies have shown SS to have a **slightly detrimental effect on performance**. A study on elite college sprinters showed that pre-run SS significantly increased their 40 meter sprint time, meaning it actually inhibited sprint performance (Winchester et al 2008).



A systematic review based on 106 papers concluded that SS of 30-45 seconds has no positive or detrimental effects on muscle performance but SS of longer duration (>60 seconds) may have detrimental effects on eccentric muscle strength (Kay et al 2012). A meta-analysis based on 104 studies evaluating the effects of SS on muscular performance states, ***"We conclude that the usage of SS as the sole activity during warm-up routine should generally be avoided."*** (Simic et al 2013).

Instead of discussing every one of the 104 studies mentioned above, here is a sample one where 30 recreational gym goers were given a standardized 10-week strength training protocol, then were randomly assigned to one of three groups. The first group was provided with no SS exercises, the second group was instructed on performing SS pre-workout and the third group was instructed on performing SS in between every training set. Here is the word by word conclusion of this study published in the *Journal of Strength and Conditioning Research*, ***"... strength training performed without any type of stretching exercise, regardless of whether the stretching is performed before or during the lifting session, can more effectively increase muscle strength"*** (Borges Bastos et al 2013).

To evaluate the potential effects of stretching on vertical jumping height, 100 athletes

performed vertical jumps 2 minutes after various stretching protocols. They demonstrated that athletes who performed either static or proprioceptive neuromuscular facilitation (PNF) stretches had **decreased** vertical jump performance but on the other hand those who performed ballistic stretching had increased vertical jump performance (Place et al 2013).

In the past decade studies have either shown that SS has a negative influence or at best no influence on endurance performance of activities such as walking, running or cycling (Mojock et al 2011, Hayes et al 2007, Allison et al 2008). To quote another paper published in the *Journal of Strength and Conditioning Research*, ***"...static stretching should be avoided before a short endurance bout."*** (Lowery et al 2014).

Other options for improving athletic performance

There are certainly hundreds of published studies on means of improving athletic performance such a adequate hydration (Maughan 2010), proper nutrition (Zoroob et al 2013), neuromuscular warm up (Herman et al 2012), strength training (McGuigan et al 2012), and psychological preparation (Luiselli 2010). The point is: there are several other more effective ways of potentially improving athletic performance and SS is not one of them!

Clinical Conclusion #2: Based on the available evidence, we can conclude that SS does not appear to improve muscular contractions and in some cases actually hinders them. Warm-ups and strength and endurance training involving functional movements simulating the athletic performance continue to be the best methods of improving athletic performance.

Assumption #3: The current evidence supports that SS reduces post-exercise muscle soreness.
☐ True ☑ False

The 2011 Cochrane review based on 12 studies published over the last 25 years concluded that SS does not prevent muscle soreness that occurs 8 to 24 hours after vigorous exercise.

"The evidence from randomised studies suggests that muscle stretching, whether conducted before, after, or before and after exercise, does not produce clinically important reductions in delayed-onset muscle soreness in healthy adults." (Herbert et al 2011).

Other options for reducing post-exercise muscle soreness

A warm-up performed immediately before an unaccustomed eccentric exercise has been shown to have small reductions in delayed-onset muscle soreness (Law & Herbert 2007, Ingham et al 2010). However the single most effective method of minimizing this soreness is the common sense approach of starting a novel exercise or activity gradually and progressing the intensity over a period of 1 or 2 weeks (Cheung et al 2003).

Clinical Conclusion #3: Based on the available evidence we can conclude that SS neither prevents nor reduces post exercise muscle soreness, whereas a warm-up and gradual exercise intensity progression appear to be the best methods of preventing this adverse effect.

Assumption #4: The current evidence supports that SS reduces the risk of injuries.
☐ True ☑ False

To reduce the risk of musculoskeletal injuries, it is common for professional and recreational athletes to perform various stretching routines

prior to their athletic activities. Considering the extreme popularity of this hypothesis, one would believe in the existence of over-whelming evidence supporting the notion that SS reduces the risk of future injuries. The challenge in proving or disproving this hypothesis is that the risk factors for various musculoskeletal injuries are multi-factorial and complex.

Admittedly there are a few studies that do support tightness and restrictions in ROM to be risk factors in injury recurrences (Jonhagen et al 1994, Witvrouw et al 2001), however these studies still do not necessarily support SS for injury prevention. For example increased hamstring or quadriceps muscle tightness in soccer players has been shown to be a risk for subsequent musculoskeletal injuries (Witvrouw et al 2003), yet this finding does not automatically indicate that if the athletes had stretched their hamstring or quadriceps, they would have prevented their injuries.

A study on Australian footballers showed that the toe-touch test, measuring lumbar flexion and hamstring flexibility, was **not a useful screening tool** to identify footballers at risk for hamstring strain (Bennle et al 1999).

Another study on 30 elite Norwegian soccer teams demonstrated **no difference** in the incidence of hamstring strains between the teams that used a flexibility training program and those who did not (Arnason et al 2008).

This is one of largest studies on SS involving over 1500 new army recruits who were randomly allocated to either a daily warm-up and stretching exercises or only warm up exercises for 3 months. The stretching exercises included 20 seconds of SS involving the six major lower extremity muscles (gluteals, hip flexors, quadriceps, hamstrings, adductors, and ankle plantar flexors) before their daily physical training sessions. During the 3 months of training, 333 lower limb injuries ranging from muscle strains to stress fractures were recorded, however there was no effect of pre-exercise stretching on injury risk. Interestingly the two factors that predicted injury risk, were pre-existing fitness test (20m shuttle run score) and age (Pope et al 2000).

Here is a quote from a paper published in the *British Medical Journal* ***"... muscle stretching before exercising does not produce meaningful reductions in the risk of injury."*** (Herbert et al 2002) and another one published in the *Medicine and Science in Sports and Exercise* journal, ***"Stretching was not significantly associated with a reduction in total injuries"*** (Thacker et al 2004).

Thus far, 3 systematic reviews have all reached the same conclusion: SS exercises **are proven to be not beneficial for sports injury prevention** (Thacker et al 2004, Hart 2005, Lauersen et al 2014).

Other options for reducing the risk of future injuries

Based on the previously mentioned study on Norwegian soccer teams, although SS failed to work, they demonstrated significantly lower incidences of hamstring strains in teams who used an eccentric training program when compared to the teams that did not use the program. Thus, eccentric strengthening was an effective method of reducing the risk of hamstring injuries (Arnason et al 2007).

Similarly, a study on Swedish soccer players who had sustained hamstring injuries demonstrated those who performed eccentrically focused exercises had almost half the recovery time when compared to those who received stretching and conventional exercises (Askling et al 2013).

There is now strong evidence that gradual progressive strength training performed consistently can greatly reduce the risk of occurrence and recurrence of various musculoskeletal injuries (Lauersen et al 2014). A paper published in the *British Journal of Sports Medicine* concluded that ***"Strength training reduced sports injuries to less than 1/3 and overuse injuries could be almost halved."*** (Lauersen et al 2014).

Clinical Conclusion #4: Based on the available evidence, we can safely conclude that SS is not effective at reducing the risk of musculoskeletal injuries. On the other hand appropriate neuromuscular warm-up and eccentric strength training exercises appear to dramatically reduce the risk of injury and improve recovery following muscle and tendon injuries.

Grand Conclusion: Despite the growing worldwide popularity of SS over the past number of decades, personal trainers, coaches and health care providers must consider the overwhelming evidence that SS may not be an effective means of i) improving muscular and tendon flexibility ii) improving athletic performance iii) reducing post exercises soreness and most importantly, SS is not effective in iv) reducing the risk of future musculoskeletal injuries.

In contrast to SS, dynamic stretching and eccentric strengthening may stimulate mechanoreceptors, augment proprioception, and potentially reduce injury risk and improve athletic performance. Future studies should focus on the effects of dynamic stretching and neuromuscular warm-ups simulating the functional movement pattern of the particular activity or sport. **Perhaps the time has come to put our obsession with static stretching to rest!**

Personal Comment: Before ending this paper, I must make a confession so no one thinks I am a hypocrite. I do my 3 minute Yoga sun salutation ñstretchesò every single day. I do not consider this static stretching though, but rather brief repeated movements into end-range. I certainly endorse the prescription and performance of regular end-range pain-free movements, especially when a movement reduces symptoms or is restricted following an injury or a period of immobility.

I cannot recall a time when I ever consciously stretched before a run. Instead of static stretches, I do weird looking rapid movement warm ups for a few minutes while I jog. I do the classic sprinters dynamic stretches which includes butt kicks, knee ups and kick ups. I also vary my running stance from wide to crisscrossing my steps. Then I do crisscross jogs sideways and end off with a few full turns. I may look silly doing them but I feel those childish movements are waking up my mechanoreceptors and potentially preventing injury...

…and so far so good.

If you found this paper valuable, please read my rants on **"Ice"** and on **"NSAIDs".** We need to put evidence into practice, instead of just accepting common practices. Articles found on **www.aptei.com**

Sincerely, Bahram Jam, PT

Questioning the use of NSAIDs Given Inflammation is a Healthy Response Following Acute Musculoskeletal Injuries

Questioning the use of ICE Given Inflammation is a Healthy Response Following Acute Musculoskeletal Injuries

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