Stretching Exercises for Active Sports Participants - A Vision

Prasad Salian[1], Dr.Neethi[2] and Dr. Ashok Kumar[3]

[1]Assistant Director of Physical Education and Sports, Government Engineering College, Kushalnagara, Kodagu, India.
[2]Assistant Director, Thiru. Vi. Ka Government Arts College Thiruvarur, Thamilnadu.
[3]Assistant Professor of Physical education, College of Horticulture, UHS Campus, Bengaluru, India

Abstract: Stretching is a common activity used by athletes, older adults, rehabilitation patients, and anyone participating in a fitness program. While the benefits of stretching are known, controversy remains about the best type of stretching for a particular goal or outcome. The purpose of this clinical commentary is to discuss the current concepts of muscle stretching interventions and summarize the evidence related to stretching as used in both exercise and rehabilitation.
Keywords: Stretching, Exercises, Active, Sports, Participants, Vision.

I. Introduction

Stretching is a form of physical exercise in which a specific skeletal muscle (or muscle group) is deliberately elongated, often by abduction from the torso, in order to improve the muscle's felt elasticity and reaffirm comfortable muscle tone. The result is a feeling of increased muscle control, flexibility and range of motion. Stretching is also used therapeutically to alleviate cramps. In its most basic form, stretching is a natural and instinctive activity; it is performed by humans and many animals. It can be accompanied by yawning. Stretching often occurs instinctively after waking from sleep, after long periods of inactivity, or after exiting confined spaces and areas. Increasing flexibility through stretching is one of the basic tenets of physical fitness. It is common for athletes to stretch before and after exercise in order to reduce injury and increase performance. Stretching can strengthen muscles, and in turn strong muscles are important to stretching safely and effectively. Stretching can be dangerous when performed incorrectly. There are many techniques for stretching in general, but depending on which muscle group is being stretched, some techniques may be ineffective or detrimental, even to the point of causing permanent damage to the tendons, ligaments and muscle fiber.

Studies have shed light on a large protein within skeletal muscles named titin. A study performed Law demonstrated that the origin of passive muscle tension (which occurs during stretching) is actually within the myofibrils, not extracellular as had previously been supposed. Due to neurological safeguards against injury, it is normally impossible for adults to stretch most muscle groups to their fullest length without training due to the activation of muscle antagonists as the muscle reaches its normal range of motion.

Stretching is just about the simplest of all physical activities. It is the perfect antidote for long periods of inactivity and holding still.

- Regular stretching throughout the day will:
-
- Reduce muscle tension
- Improve circulation
- Reduce anxiety, stress, and fatigue
- Improve mental alertness
- Decrease the risk of injury
- Make your work easier
- Tune your mind into your body
- Make you feel better!

II. Review of Related Literature

One review suggests that there are many beneficial stretches that can improve range of motion (ROM) in athletes, especially runners. Another study found that classic "static stretching" did not prevent injuries for runners. Also, certain stretching techniques and protocols prevent injuries when performed (within 15 minutes) prior to exercise. However, stretching does not prevent delayed onset muscle soreness, either when performed before or after exercise, according to a Cochrane review in 2006.

It is also suggested that one stretching exercise may not be enough to prevent all types of injury, and therefore, multiple stretching exercises should be used to gain the full effects of stretching. It has also been suggested that "Proprioceptive neuromuscular facilitation (PNF) stretching yield the greatest change in range of motion, especially short-term benefits. Reasoning behind the biomechanical benefit of PNF stretching points to muscular reflex relaxation found in the musculotendinous unit being stretched. Others suggest that PNF benefits are due to influence on the joint where the stretch is felt.
Over-stretching or stretching to a point where pain is felt may be inappropriate and detrimental. Effects on performance, both short- and long-term, may include predisposition to injury and possible nerve damage.

Other research concludes that active stretching routines will reduce muscle-tendon viscosity and increase muscle compliancy and elasticity. In sports activities where there are little or no short-stretching cycles, (bicycling, jogging, etc.) stretching routines may be detrimental to athletic performance and have no effect on reducing injuries.
Stretching may also cause ischemia in muscles, which reduces oxygen levels and the ability to remove metabolic waste. Higher levels of metabolic waste create a catalyst that contracts muscles. This may cause muscle injury in individual performance.
Other theories included claim active static stretching increases inflow of Ca^{2+} from extra cellular spaces into the muscles being stretched. The increase of Ca^{2+} reduced the muscle twitch tension by up to sixty percent. Reasoning behind this claim is that increased levels of Ca^{2+} in resting muscles predisposes individuals to fatigue quicker than individuals who did not stretch.
Just as there are different types of flexibility, there are also different types of stretching. Stretches are either dynamic (meaning they involve motion) or static (meaning they involve no motion). Dynamic stretches affect dynamic flexibility and static stretches affect static flexibility (and dynamic flexibility to some degree).

The different types of stretching:

1. ballistic stretching
2. dynamic stretching
3. active stretching
4. passive (or relaxed) stretching
5. static stretching
6. isometric stretching
7. PNF stretching

Ballistic Stretching

- Dynamic Stretching
- Types of Stretching

Ballistic stretching uses the momentum of a moving body or a limb in an attempt to force it beyond its normal range of motion. This is stretching, or "warming up", by bouncing into (or out of) a stretched position, using the stretched muscles as a spring which pulls you out of the stretched position. (e.g. bouncing down repeatedly to touch your toes.) This type of stretching is not considered useful and can lead to injury. It does not allow your muscles to adjust to, and relax in, the stretched position. It may instead cause them to tighten up by repeatedly activating the stretch reflex.

Dynamic Stretching

- Active Stretching
- Ballistic Stretching
- Types of Stretching

Dynamic stretching, according to *Kurz*, "involves moving parts of your body and gradually increasing reach, speed of movement, or both." Do not confuse dynamic stretching with ballistic stretching! Dynamic stretching consists of controlled leg and arm swings that take you (gently!) to the limits of your range of motion. Ballistic stretches involve trying to force a part of the body *beyond* its range of motion. In dynamic stretches, there are no bounces or "jerky" movements. An example of dynamic stretching would be slow, controlled leg swings, arm swings, or torso twists.

Dynamic stretching improves dynamic flexibility and is quite useful as part of your warm-up for an active or aerobic workout (such as a dance or martial-arts class). See section warming Up.

According to *Kurz*, dynamic stretching exercises should be performed in sets of 8-12 repetitions. Be sure to stop when and if you feel tired. Tired muscles have less elasticity which decreases the range of motion used in your movements. Continuing to exercise when you are tired serves only to reset the nervous control of your muscle length at the reduced range of motion used in the exercise (and will cause a loss of flexibility). Once you attain a maximal range of motion for a joint in any direction you should stop doing that movement during that workout. Tired and overworked muscles won't attain a full range of motion and the muscle's kinesthetic memory will remember the repeated shorted range of motion, which you will then have to overcome before you can make further progress.

Active Stretching

- Passive Stretching
- Dynamic Stretching

- Types of Stretching

Active stretching is also referred to as *static-active stretching*. An active stretch is one where you assume a position and then hold it there with no assistance other than using the strength of your agonist muscles (see section Cooperating Muscle Groups). For example, bringing your leg up high and then holding it there without anything (other than your leg muscles themselves) to keep the leg in that extended position. The tension of the agonists in an active stretch helps to relax the muscles being stretched (the antagonists) by reciprocal inhibition .

Active stretching increases active flexibility and strengthens the agonistic muscles. Active stretches are usually quite difficult to hold and maintain for more than 10 seconds and rarely need to be held any longer than 15 seconds.

Many of the movements (or stretches) found in various forms of yoga are active stretches.

Passive Stretching

- Static Stretching
- Active Stretching
- Types of Stretching

Passive stretching is also referred to as *relaxed stretching*, and as *static-passive stretching*. A passive stretch is one where you assume a position and hold it with some other part of your body, or with the assistance of a partner or some other apparatus. For example, bringing your leg up high and then holding it there with your hand. The splits is an example of a passive stretch (in this case the floor is the "apparatus" that you use to maintain your extended position).

Slow, relaxed stretching is useful in relieving spasms in muscles that are healing after an injury. Obviously, you should check with your doctor first to see if it is okay to attempt to stretch the injured muscles.

Relaxed stretching is also very good for "cooling down" after a workout and helps reduce post-workout muscle fatigue, and soreness.

Static Stretching

- Isometric Stretching
- Passive Stretching
- Types of Stretching

Many people use the term "passive stretching" and "static stretching" interchangeably. However, there are a number of people who make a distinction between the two. According to *M. Alter*, *Static stretching* consists of stretching a muscle (or group of muscles) to its farthest point and then maintaining or holding that position, whereas *Passive stretching* consists of a relaxed person who is relaxed (passive) while some external force (either a person or an apparatus) brings the joint through its range of motion.

Notice that the definition of passive stretching given in the previous section encompasses *both* of the above definitions. Throughout this document, when the term *static stretching* or *passive stretching* is used, its intended meaning is the definition of passive stretching as described in the previous section. You should be aware of these alternative meanings, however, when looking at other references on stretching.

Isometric Stretching

- PNF Stretching
- Static Stretching
- Types of Stretching

Isometric stretching is a type of static stretching (meaning it does not use motion) which involves the resistance of muscle groups through isometric contractions (tensing) of the stretched muscles (see section Types of Muscle Contractions). The use of isometric stretching is one of the fastest ways to develop increased static-passive flexibility and is much more effective than either passive stretching or active stretching alone. Isometric stretches also help to develop strength in the "tensed" muscles (which helps to develop static-active flexibility), and seems to decrease the amount of pain usually associated with stretching.

The most common ways to provide the needed resistance for an isometric stretch are to apply resistance manually to one's own limbs, to have a partner apply the resistance, or to use an apparatus such as a wall (or the floor) to provide resistance.An example of manual resistance would be holding onto the ball of your foot to keep it from flexing while you are using the muscles of your calf to try and straighten your instep so that the toes are pointed.An example of using a partner to provide resistance would be having a partner hold your leg up high (and keep it there) while you attempt to force your leg back down to the ground.An example of using the wall to provide resistance would be the well known "push-the-wall" calf-stretch where you are actively attempting to move the wall (even though you know you can't).

Isometric stretching is *not* recommended for children and adolescents whose bones are still growing. These people are usually already flexible enough that the strong stretches produced by the isometric contraction have a much higher risk of damaging tendons and connective tissue. *Kurz* strongly recommends preceding any isometric stretch of a muscle with dynamic strength training for the muscle to be stretched. A full session of isometric stretching makes a lot of demands on the muscles being stretched and should not be performed more than once per day for a given group of muscles (ideally, no more than once every 36 hours).

The proper way to perform an isometric stretch is as follows:

1. Assume the position of a passive stretch for the desired muscle.
2. Next, tense the stretched muscle for 7-15 seconds (resisting against some force that will not move, like the floor or a partner).
3. Finally, relax the muscle for at least 20 seconds.

Some people seem to recommend holding the isometric contraction for longer than 15 seconds, but according to *SynerStretch* (the videotape), research has shown that this is not necessary. So you might as well make your stretching routine less time consuming.

- How Isometric Stretching Works

How Isometric Stretching Works

- Isometric Stretching: (beginning of section)

Recall from our previous discussion (see section How Muscles Contract) that there is no such thing as a partially contracted muscle fiber: when a muscle is contracted, some of the fibers contract and some remain at rest (more fibers are recruited as the load on the muscle increases). Similarly, when a muscle is stretched, some of the fibers are elongated and some remain at rest (see section What Happens When You Stretch). During an isometric contraction, some of the resting fibers are being pulled upon from both ends by the muscles that are contracting. The result is that some of those resting fibers stretch!

Normally, the handful of fibers that stretch during an isometric contraction are not very significant. The true effectiveness of the isometric contraction occurs when a muscle that is already in a stretched position is subjected to an isometric contraction. In this case, some of the muscle fibers are already stretched before the contraction, and, if held long enough, the initial passive stretch overcomes the stretch reflex (see section The Stretch Reflex) and triggers the lengthening reaction (see section The Lengthening Reaction), inhibiting the stretched fibers from contracting. At this point, according to *SynerStretch*, when you isometrically contracted, some resting fibers would contract and some resting fibers would stretch. Furthermore, many of the fibers already stretching may be prevented from contracting by the inverse myotatic reflex (the lengthening reaction) and would stretch even more. When the isometric contraction is completed, the contracting fibers return to their resting length but the stretched fibers would remember their stretched length and (for a period of time) retain the ability to elongate past their previous limit. This enables the entire muscle to stretch beyonds its initial maximum and results in increased flexibility.

The reason that the stretched fibers develop and retain the ability to stretch beyond their normal limit during an isometric stretch has to do with the muscle spindles (see section Proprioceptors): The signal which tells the muscle to contract voluntarily, also tells the muscle spindle's (intrafusal) muscle fibers to shorten, increasing sensitivity of the stretch reflex. This mechanism normally maintains the sensitivity of the muscle spindle as the muscle shortens during contraction. This allows the muscle spindles to habituate (become accustomed) to an even further-lengthened position.

PNF Stretching

- Isometric Stretching
- Types of Stretching

PNF stretching is currently the fastest and most effective way known to increase static-passive flexibility. PNF is an acronym for *proprioceptive neuromuscular facilitation*. It is not really a type of stretching but is a technique of combining passive stretching (see section Passive Stretching) and isometric stretching (see section Isometric Stretching) in order to achieve maximum static flexibility. Actually, the term PNF stretching is itself a misnomer. PNF was initially developed as a method of rehabilitating stroke victims. PNF refers to any of several *post-isometric relaxation* stretching techniques in which a muscle group is passively stretched, then contracts isometrically against resistance while in the stretched position, and then is passively stretched again through the resulting increased range of motion. PNF stretching usually employs the use of a partner to provide resistance against the isometric contraction and then later to passively take the joint through its increased range of motion. It may be performed, however, without a partner, although it is usually more effective with a partner's assistance.

Most PNF stretching techniques employ *isometric agonist contraction/relaxation* where the stretched muscles are contracted isometrically and then relaxed. Some PNF techniques also employ *isometric antagonist contraction* where the antagonists of the stretched muscles are contracted. In all cases, it is important to note that the stretched muscle should be rested (and relaxed) for at least 20 seconds before performing another PNF technique. The most common PNF stretching techniques are:

Hold-Relax

This technique is also called the *contract-relax*. After assuming an initial passive stretch, the muscle being stretched is isometrically contracted for 7-15 seconds, after which the muscle is briefly relaxed for 2-3 seconds, and then immediately subjected to a passive stretch which stretches the muscle even further than the initial passive stretch. This final passive stretch is held for 10-15 seconds. The muscle is then relaxed for 20 seconds before performing another PNF technique.

Hold-Relax-contract

This technique is also called the *contract-relax-contract*, and the *contract-relax-antagonist-contract* (or *CRAC*). It involves performing two isometric contractions: first of the agonists, then, of the antagonists. The first part is similar to the hold-relax where, after assuming an initial passive stretch, the stretched muscle is isometrically contracted for 7-15 seconds. Then the muscle is relaxed while its antagonist immediately performs an isometric contraction that is held for 7-15 seconds. The muscles are then relaxed for 20 seconds before performing another PNF technique.

Hold-Relax-swing

This technique (and a similar technique called the *hold-relax-bounce*) actually involves the use of dynamic or ballistic stretches in conjunction with static and isometric stretches. It is **very** risky, and is successfully used only by the most advanced of athletes and dancers that have managed to achieve a high level of control over their muscle stretch. It is similar to the hold-relax technique except that a dynamic or ballistic stretch is employed in place of the final passive stretch.

Notice that in the hold-relax-contract, there is no final passive stretch. It is replaced by the antagonist-contraction which, via reciprocal inhibition, serves to relax and further stretch the muscle that was subjected to the initial passive stretch. Because there is no final passive stretch, this PNF technique is considered one of the safest PNF techniques to perform (it is less likely to result in torn muscle tissue). Some people like to make the technique even more intense by adding the final passive stretch after the second isometric contraction. Although this can result in greater flexibility gains, it also increases the likelihood of injury.

Even more risky are dynamic and ballistic PNF stretching techniques like the hold-relax-swing, and the hold-relax-bounce. If you are not a professional athlete or dancer, you probably have no business attempting either of these techniques (the likelihood of injury is just too great). Even professionals should not attempt these techniques without the guidance of a professional coach or training advisor. These two techniques have the greatest potential for rapid flexibility gains, but only when performed by people who have a sufficiently high level of control of the stretch reflex in the muscles that are being stretched.

Like isometric stretching, PNF stretching is also not recommended for children and people whose bones are still growing (for the same reasons. Also like isometric stretching, PNF stretching helps strengthen the muscles that are contracted and therefore is good for increasing active flexibility as well as passive flexibility. Furthermore, as with isometric stretching, PNF stretching is very strenuous and should be performed for a given muscle group no more than once per day (ideally, no more than once per 36 hour period).

The initial recommended procedure for PNF stretching is to perform the desired PNF technique 3-5 times for a given muscle group (resting 20 seconds between each repetition). However, *HFLTA* cites a 1987 study whose results suggest that performing 3-5 repetitions of a PNF technique for a given muscle group is not necessarily any more effective than performing the technique only once. As a result, in order to decrease the amount of time taken up by your stretching routine (without decreasing its effectiveness), *HFLTA* recommends performing only one PNF technique per muscle group stretched in a given stretching session.

- How PNF Stretching Works

How PNF Stretching Works

- PNF Stretching: (beginning of section)

Remember that during an isometric stretch, when the muscle performing the isometric contraction is relaxed, it retains its ability to stretch beyond its initial maximum length (see section How Isometric Stretching Works). Well, PNF tries to take immediate advantage of this increased range of motion by immediately subjecting the contracted muscle to a passive stretch.

The isometric contraction of the stretched muscle accomplishes several things:

1. As explained previously (see section How Isometric Stretching Works), it helps to train the stretch receptors of the muscle spindle to immediately accommodate a greater muscle length.
2. The intense muscle contraction, and the fact that it is maintained for a period of time, serves to fatigue many of the fast-twitch fibers of the contracting muscles (see section Fast and Slow Muscle Fibers). This makes it harder for the fatigued muscle fibers to contract in resistance to a subsequent stretch (see section The Stretch Reflex).
3. The tension generated by the contraction activates the golgi tendon organ (see section Proprioceptors), which inhibits contraction of the muscle via the lengthening reaction (see section The Lengthening Reaction). Voluntary contraction during a stretch increases tension on the muscle, activating the golgi tendon organs more than the stretch alone. So, when the voluntary contraction is stopped, the muscle is even more inhibited from contracting against a subsequent stretch.

PNF stretching techniques take advantage of the sudden "vulnerability" of the muscle and its increased range of motion by using the period of time immediately following the isometric contraction to train the stretch receptors to get used to this new, increased, range of muscle length. This is what the final passive (or in some cases, dynamic) stretch accomplishes.

III. Conclusion

To increase joint range of motion all types of stretching are effective, PNF-type stretching may be more effective for immediate gains. Dynamic stretching is recommended for warm-up for athletes before competition or activity.As static stretching will likely decrease strength and may influence performance. Post exercise static stretching or Proprioceptive Neuromuscular Facilitation stretching is recommended for reducing muscle injuries and increasing joint range of motion.[18] Although Stretching has not been shown to be effective at reducing the incidence of overall injuries.Stretching is often included in Physiotherapy interventions for management of many kinds of clinical injuries. Despite positive outcomes, it is difficult to isolate the effectiveness of the stretching component of the total treatment plan because the protocols usually include strengthening and other interventions in addition to stretching. Despite stretching not having strong evidence in research, it is highly sought by Physiotherapists for an effective long-term treatment modality.

John's, Canada

References

1. Agre, JC. 1985. Hamstring injuries. Proposed aetiological factors, prevention and treatment. *Journal of Sports Medicine*, 2: 21–33. [Google Scholar]
2. Amako, M, Oda, T, Masuoka, K, Yokoi, H and Campisi, P. 2003. Effect of static stretching on prevention of injuries for military recruits. *Journal of Military Medicine*, 168(6): 442–446. [Crossref], [PubMed], [Web of Science ®], [Google Scholar]
3. Ball, D and Herrington, L. 1998. Training and overload: Adaptation and failure in the musculoskeletal system. *Journal of Bodywork and Movement Therapies*, 2(3): 161–167. [Google Scholar]
4. Batterham, AM and Atkinson, G. 2005. How big does my sample size need to be? A primer on the murky world of sample size estimation. *Journal of Physical Therapy in Sport*, 6: 153–163. [Crossref], [Web of Science ®], [Google Scholar]
5. Bixler, BA and Jones, RL. 1992. High-school football injuries: Effects of post-half time warm-up and stretching routine. *Family Practice Research Journal*, 12(2): 131–139. [Google Scholar]
6. Cornelius, WL and Hinson, MM. 1980. The relationship between isometric contractions of hip extensors and subsequent flexibility in males. *Journal of Sports Medicine and Physical Fitness*, 20: 75–80. [PubMed], [Web of Science ®], [Google Scholar]
7. Cross, KM and Worrell, TW. 1999. Effects of a static stretching program on the incidence of lower extremity musculotendinous strains. *Journal of Athletic Training*, 34(1): 11–14. [PubMed], [Web of Science ®], [Google Scholar]
8. Ekstrand, J and Gillquist, J. 1983. The avoidability of soccer injuries. *International Journal of Sports Medicine*, 4: 124–128. [Crossref], [PubMed], [Web of Science ®], [Google Scholar]
9. Ekstrand, J, Gillquist, J and Liljedahl, S-O. 1983. Prevention of soccer injuries: Supervision by doctor and physiotherapist. *American Journal of Sports Medicine*, 11: 116–120. [Crossref], [PubMed], [Web of Science ®], [Google Scholar]
10. Finestone, A, Shlamkovitch, N, Eldad, A and Wosk, J. 1991. Risk factors for stress fractures among Israeli infantry recruits. *Journal of Military Medicine*, 156: 528–530. [PubMed], [Web of Science ®], [Google Scholar]

11. Godges, JJ, MacRae, H, Longdon, C, Tinberg, C and MacRae, P. 1989. The effects of two stretching procedures on hip range of motion and gait economy. *Journal of Orthopedic Sports Physical Therapy*, 1: 350–357. [Google Scholar]

12. Greenhalgh, T. 1997. "Papers that summarise other papers (systematic reviews and meta-analysis)". In *British Medical Journal*, Clinical research 672–675. 13;315(7109) [Google Scholar]

13. Hägglund, M, Waldén, M, Balu, R and Ekstrand, J. 2005. Methods for epidemiological study of injuries to professional players: Developing the UEFA model. *British Journal of Sports Medicine*, 39: 340–346. [Crossref], [PubMed], [Web of Science ®], [Google Scholar]

14. Hartig, DE and Henderson, JM. 1999. Increasing hamstring flexibility decreases lower extremity overuse injuries in military basic trainees. *American Journal of Sport Medicine*, 27(2): 173–176. [Crossref], [Google Scholar]

15. Herbert, RD and Gabriel, M. 2002. Effects of stretching before and after exercising on muscle soreness and risk of injury: Systematic review. *British Medical Journal*, 325: 468 [Crossref], [PubMed], [Web of Science ®], [Google Scholar]

16. Hess, GP, Cappiello, WL and Pole, RM. 1987. Prevention and treatment of overuse tendon injuries. *Journal of Sports Medicine*, 8: 371–384. [Google Scholar]

17. Ingraham, SJ. 2003. The role of flexibility in injury prevention and athletic performance: Have we stretched the truth?. *Journal of Minnesota Medicine*, 86(5): 58–61. [Google Scholar]

18. Jones, DC, Cowan, DL and Tomlinson, JP. 1993. Epidemiology of injuries associated with physical training among young men in the army. *Journal of Medicine and Science in Sports and Exercise*, 25: 197–203. [Crossref], [PubMed], [Web of Science ®], [Google Scholar]

19. Koes, BW, Assendelft, WJJ, van der Heijden, GJMG, Bouter, LM and Knipschild, PG. 1991. Spinal manipulation and mobilization for back and neck pain: a blinded review. *British Medical Journal*, 303: 1289–1303. [Google Scholar]

20. Lysens, RJ, Ostyn, MS, Auweele, YV, Lefevre, J, Vuylsteke, M and Renson, L. 1989. The accident-prone and overuse-prone profiles of the young athlete. *American Journal of Sports Medicine*, 17: 612–619. [Crossref], [PubMed], [Web of Science ®], [Google Scholar]

21. McCullough, C. 1990. Stretching for injury prevention. *Journal of Patient Management*, 14(6): 79–85. [Google Scholar]