# *Flexibility*

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ne of the five health related components of fitness is flexibility. Flexibility relates to the ability to move a joint through it’s full range of motion (ROM). To develop a complete fitness program, you should take time to emphasize this component in your routine by stretching. Unfortunately, “…most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention.” (American Council on Exercise)

Flexibility is classified into two types: static and dynamic. **Static flexibility** is a measure of the limits of a joints overall range of motion. It’s measured by stretching and holding a joint in the position of it’s maximum range while using a measuring instrument to quantify that range. To achieve the maximum range, passive forces are required (force generated from an external source). **Dynamic flexibility** is a measure of overall joint stiffness during movement. Unlike static flexibility, dynamic flexibility requires active force production (your own muscles contracting). Because it’s difficult to quantify “stiffness,” dynamic flexibility is measured more subjectively. For example, how easy is it to swing a tennis racket, climb steps, or get in and out of a car? The target of any good stretching program is to improve static and dynamic flexibility so that normal ROM can be achieved. The term “normal” relates to population studies that have measured various areas of the body and established an average degree of movement for a particular joint.

# The Benefits of Flexibility and Stretching

There are many benefits to regular stretching with the most important of those being simple: being flexible will help you move freely and complete activities with greater ease.

## Healthy Joints and Pain Management

As many as 28 percent of all adults report pain and stiffness in joints. That number increases dramatically with age and women are more likely to develop joint symptoms. For adults, arthritis is one of the most common conditions with 54% of people 75 years and older having been diagnosed with arthritis. Regular exercise, including regular stretching, is essential for people with arthritis to maintain function and manage joint pain. Even for those not affected by joint conditions, stretching increases joint mobility and function, and decreases joint stiffness and pain.

Pain can also be related to imbalances in the muscles. For example, if the front of your thighs and hips get too tight from a lack of flexibility, the tension will pull on the hips (where the muscles are attached). The result is the pelvis may be pulled forward and cause greater sway in your lower back. This affects your posture and can eventually lead to pain and stiffness in the neck, shoulders and lower back. Stretching regularly, for all major muscle groups/joint areas, promotes good alignment and balance.

## Muscle Relaxation and Stress Relief

Staying in one position for long periods of time, repetitive movements, and other everyday stressors can result in stiff muscles and knots (also called trigger points). Regular stretching decreases anxiety, blood pressure, and breathing rate which help to relax muscles and aches and pains related to neuromuscular tension (stress). Flexibility has also been prescribed successfully to treat dysmenorrhea (painful menstruation) and to relieve muscle cramps during participation of exercise/sports.

## Other Benefits

In addition to the benefits listed above, several other benefits have been researched and characterized as good reasons maintain a regular routine of stretching:

* Increased blood flow- Blood carries vital nutrients and oxygen to muscles and tissues. Stretching increases blood flow to the muscles being stretched which may help them recover from exercise faster.
* Reduction of Future Lower Back Pain-Most experts agree (while research is still inconclusive) that counteracting the natural loss in muscle and connective tissue elasticity that occurs with aging with muscle fitness and stretching exercises can reduce your risk of developing lower-back pain.

## Flexibility and Aging

For many young adults, the thought of long term flexibility can be taken for granted. For example, how hard is it to bend over and tie your shoes? How difficult is it to walk around campus with a backpack? As young adults, most of those activities are likely encountered with little pain or resistance. However, ROM declines with age. Simple things like rotating the head and neck to glance over the shoulders, getting in and out of a vehicle, or carrying groceries can be painful. Therefore, flexibility is critical to maintaining a high quality of life in older years.

## The Inactivity-Mobility Cycle

If you have ever been injured to the point that required immobilization of a joint, you realize how important mobility is in relation to your overall health. Unfortunately, as joints ROM is restricted from arthritis or other injuries, activity declines. As activity declines, the ROM likely continues to suffer as a result of inactivity and the vicious cycle ensues. A simple stretching program can help alleviate this problem and help break out of the cycle.

# Improving Range of Motion

Joint ROM results from a combination of factors which could be classified as internal or external. Internal structures relate to the physical structures of body materials and tissue. External factors are non-structural and include environmental temperature, gender, age, excess fat mass, muscle mass, and restrictions in clothing or equipment.

Internal factors include joint structure/joint mechanics and the connective and soft tissue surrounding the joint. Because muscular actions such as muscular contractions and stretching are controlled by the nervous system, another internal factor can be attributed to the neuromuscular system and how the stretching and tension is managed.

## Joint Structure

A joint is a location on the body in which two or more bones intersect and interact. For example, the humerus (upper arm) intersects with the radius and ulna (lower arm) at the point of the elbow. The bony formation of each joint structurally limits the ROM. For example, the shoulder joint which is structurally a ball-in-socket joint, can rotate in multiple directions. In other words, it has a wide range of motion. However, the knee joint is a modified hinge joint which is limited to essentially a forward-backward direction of movement. Additionally, excessive fat mass surrounding a joint or even large muscle mass may limit the ROM for a particular joint. Although weight loss could affect amounts of fat mass surrounding a joint, or loss of muscle, joint structure cannot be altered. As a result, little can be done in this area to improve flexibility.

Not only is range of motion related to the joint structure, but flexibility exercises are joint-specific. In other words, you can’t stretch your hamstring and expect your shoulders to improve. Likewise, you can be flexible in your shoulder but very “stiff” in your fingers or ankles. So, a complete stretching program must include multiple stretches for various joints.

## Connective and Muscle Tissue

Joints are surrounded and connected by muscles, tendons, ligaments, and skin. For example, the head of the humerus fits into a small cavity to create the shoulder joint. However, those bones can only remain in place as a result of the muscles, tendons, and ligaments that keep the joint tight an in place. In addition, muscle tissue is surrounded with connective tissue, primarily collagen and elastin. As a joint moves through it’s normal range of motion, all of this soft tissue must stretch to accommodate the movement. Therefore, static and dynamic flexibility is probably most limited by the flexibility of the surrounding soft tissue, specifically the connective tissue.

While the exact biomechanics of how flexibility is changed isn’t well understood, it does appear to be related to the elastic and plastic properties of the connective tissue. Elasticity is defined as the ability to return to resting length after **passive stretching** (i.e. elastic recoil). Like a spring, soft tissues stretch and then recoil to their resting position. Plasticity is the tendency to assume a greater length after passive stretching (i.e. plastic deformation). In other words, taking that stretchy spring and changing the resting position to a new longer length. The goal of a flexibility program, is to repeatedly overload the elastic properties of the muscle to elicit plastic deformation over time. Several studies have suggested that a slow, sustained stretch of 30-90 seconds is necessary to produce chronic plastic deformation.

## Neuromuscular System

Modern cars come equipped with a central computer and sensors throughout to troubleshoot problems with the vehicle. Sensors in the engine determine temperature. Sensors on the wheels determine tire pressure while sensors in the gas tank tell you when the gas tank is low in fuel. Much like car, our bodies are equipped with sensors, called proprioceptors, that help us manage movement and prevent injury.

Muscles have two specific types of proprioceptors that determine the length and tension of the muscle. These proprioceptors are called muscle spindles and Golgi tendon organs (GTO’s).

Muscles spindles, lie parallel to the regular muscle and help determine the length of muscles when they are being stretched. When a muscle is stretched, they send signals to the central nervous system causing the stretched muscle to contract. In other words, there is some resistance to the stretch generated by the nervous system’s reflexive stimulus sent to the stretching muscle. This is called the myotatic or stretch reflex. Additionally, that same signal also causes the antagonist (the opposing) muscle to relax, called reciprocal inhibition. So, when you stretch your upper thigh (quadriceps) your hamstrings (antagonist to the quadriceps) are relaxed.

The GTO’s are located near the musculo-tendon junction (the end points of the muscle) and relay messages to the central nervous system regarding muscle lengthening and tension of the muscle. When activated, its signal will override the stretch reflex causing a sudden relaxation of the stretching muscle. This is called autogenic inhibition or the inverse myotatic reflex. This inhibitory reflex can only occur after the muscle has been stretched for 5 seconds or longer. This is why, in order effectively stretch, it must be done in long, slow increments of time. Otherwise, the resistance encountered from the stretch reflex will prevent the muscle from being over

In both cases, the neuromuscular system manipulates the stretched muscle by either facilitates or inhibits presumably as a protective mechanism.

# Ways to Improve Flexibility

## Stretching Techniques

Multiple stretching techniques have been researched with results showing they can be beneficial in improving ROM. Regardless of the specific technique or specific mode used, each technique can be performed using two basic modes: active or passive. **Active stretching**, also called unassisted stretching, suggests that the actual stretch is done individually without an external stimulus. **Passive stretching**, or assisted stretching is when a partner or trainer is used as the stimulus in the stretching exercise. Both modes are effective and can be applied to each of the techniques mentioned below.

### Static Stretching

The most commonly prescribed and most commonly used technique for improving flexibility is the static stretch. A static stretch involves slow, gradual and controlled movements. The muscle group is stretched toward the end of the joint ROM until the point of mild discomfort is reached. Once that point is reached, the stretch is held in a “static” position for 30 to 90 seconds. After the prescribed time, the stretch can be repeated. Common ways in which static stretching is applied would be in Yoga routines or stretching after a workout or athletic event.

Some of the major advantages for static stretching is that it is generally considered safe (see Stretches to Avoid), it is simple to perform and effective at increasing ROM. The only major disadvantage comes from when it is done too much which can reduce strength and may make joints unstable. Of course this could apply to any of the techniques.

### Ballistic Stretching

Ballistic stretching involves forceful bouncing or ball-like movements that quickly exaggerate the joint ROM without holding the position for any particular duration. This type of stretching involves dynamic movements like those done by athletes during sports events. In that regard, ballistic stretching is seen as being very specific to and beneficial for athletes. However, one criticism of ballistic stretching is that because of the short duration of the stretch, and ballistic movements that can be forceful, the muscular contraction from the stretch reflex may cause muscle soreness or even injury. For that reason, many athletic coaches feel ballistic stretching is unsafe. Also, many researchers feel it is less effective at improving ROM. Nonetheless, the ACSM still recommends ballistic as one method to effectively increase flexibility.

### Dynamic Stretching

Ballistic stretching is a form of dynamic stretching. However, when referring to dynamic stretching routines, most fitness professionals are referring to dynamic movements that don’t involve forceful bouncing motions. Instead, dynamic stretching, in this context, suggests performing exaggerated sports movements in a slower, more controlled manner. For example, a sprinter may use several exaggerated stride lengths before a race to improve hip ROM.

An advantage of dynamic stretching is that it will target and improve dynamic flexibility which in turn may improve performance. A disadvantage comes from the type of movements which often require good balance and coordination. So, learning correct form and being able to perform dynamic stretches may take a little time to learn or may not be applicable to certain populations.

### Proprioceptive Neuromuscular Facilitation (PNF) Stretching

This type of exercise usually involves a partner. The partner will passively stretch the muscle, immediately followed by an isometric muscle contraction against resistance. This contraction is then followed by another passive stretch. This type of stretch is also named contract-relax stretch because of the sequence of movements involved. Other types of PNF stretching involve contract-relax-antagonist contrac-tion, also describing the sequence of movements involved but adding an additional step.

As the name of the technique implies, PNF stretching emphasizes the natural interaction of the proprioceptors with the muscles to increase the ROM during the stretch. Remember that during the stretch, the muscle spindles cause two things to happen, the stretch reflex and reciprocal inhibition (the antagonist muscle to relax). After 5 seconds, the GTO’s then override the muscle spindle’s signals causing autogenic inhibition. Because the muscle is relaxed, it can more easily be stretched. In other words, the stretch either uses the activity of the antagonist muscle to get the target muscle to relax or the target muscle itself to relax as a result of the contraction.

While many experts feel that PNF stretching is the most effective technique, studies that compare static and PNF stretching are inconclusive. Regardless, it does appear to be very effective at increasing static flexibility. Some disadvantages to PNF is that it generally requires a knowledgeable partner, it’s somewhat complicated, and can cause some soreness from the contractions.

# Creating an Effective Stretching Program

The ACSM has made specific recommendations on how to design a flexibility program. However, before getting into the design, you should know your current flexibility status by assessing various joint’s ROM. Specifically, performing the sit-and-reach test will assess your hamstring and lower back flexibility while using a goniometer can be used to assess your ankles, knees, hips, neck and shoulders. Instructions on how to perform these assessments will follow later.

## Set Goals

Once you learn where you are most and least flexible, you should make some realistic goals to improve or maintain your ROM. Be specific when you set goals. Instead of just saying, “I want to increase my flexibility,” you will want to state the specific area of the body you intend to improve. You will also want to make sure your goal can be measured. A better way to state your goal may be, ”I will improve my sit-and-reach score by 4 cm by the end of the semester.” Notice this goal, as stated, includes a specific area, is measurable, and includes a deadline. By stating your goal properly, you will increase the likelihood of actually achieving it.

## Apply the FITT Principle

As mentioned previously, the ACSM has made recommendations for carrying out a flexibility program based on the FITT Principle (Frequency, Intensity, Time and Type). As you select the areas you want to stretch, keep in mind it is recommended that multiple stretching exercises should be performed to target all major joints including the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles. (insert link to specific exercise here). After selecting your exercises, follow the below recommendations when performing your routine. :

* Frequency-Stretch a minimum of 2-3 days per week, ideally 5-7 days per week.
* Intensity-Stretch to the point of tightness or mild discomfort.
* Time (or duration of each stretch)-a minimum of 10 seconds for very tight muscles with an emphasis to progress to 30-90 seconds. Two to four repetitions of each stretch should be done.
* Type (mode)-Select from either of the above techniques mentions that best suit your circumstances (Static, Dynamic, Ballistic, or Proprioceptive Neuromuscular Facilitation).

## When to Stretch

Although stretching can be done at any time of the day, the ACSM has traditionally recommended that flexibility training be incorporated into the warm up or cool down phase of an exercise session. Recent studies have provided evidence against stretching before exercise session suggesting that stretching will compromise the force-producing capabilities of muscles. Therefore, it is recommended that stretching take place only after the body temperature and of the muscles has increased, i.e. after the warm up or after the workout. Additional confirming evidence of this concept has shown that applying heat packs for 20 minutes to increase muscle temperature can increase hamstring flexibility more so than 30 seconds of static stretching. As you can see, temperature also plays a significant role in muscle ROM.

http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance

## Stretching Safely

In addition to warming the muscle before performing stretching exercises, there are other things that can be done to make your flexibility routine safe. When muscles are stretched quickly and forcefully, the stretch reflex can be activated. This creates significant tension because the muscle fibers will not only be stretching but also attempting to contract. As mentioned, this is one of the reasons ballistic stretching may not be suitable for everyone. To avoid this, stretch slowly and in a controlled fashion while holding the stretch for 10 seconds or more.

In addition, some stretches are not recommended, or contraindicated. Researchers have determined that some stretching exercises may not be beneficial at all or may cause injury. A list of contraindicated stretches and alternative stretches can be found by clicking on the link below. However, this is not a comprehensive list of potentially risky stretches. It is important to understand personal limitations before or during a stretch exercise to avoid injury.

### Contraindicated Stretches

http://www.mhhe.com/socscience/hhp/otw/fit\_well/web12/Web12\_IPT\_Bad\_Exercises\_Flex.htm

# Assessing Your Flexibility, Laboratory Exercises

The first step in creating a successful flexibility program is to assess your own flexibility. Follow the link below to understand how you can perform these assessements. Those that may be most helpful include sections 5.1, 5.2, and 5.3.

<http://wps.aw.com/bc_hopson_health_2/214/54825/14035385.cw/index.html>

## References

Biomechanics of Stretching

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improving Flexibility and Balance

<http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance>

video flexibility

https://youtu.be/XeEIoGMldyc