# Flexibility

Objectives:

* Define flexibility
* Examine the benefits of flexibility
* Identify ways to increase flexibility
* Create an effective stretching program
* Assess your own flexibility

**What is flexibility?**

One of the five health-related components of fitness is flexibility. Flexibility relates to the ability to move a joint through its full range of motion (ROM). Developing a complete fitness program requires taking time to emphasize this component by stretching. Unfortunately, as the American Council on Exercise points out, “Most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention.”1

Perhaps the reason it is so easy for people to overlook flexibility is because its benefits, while significant, are felt more than seen. However, failing to address this component of fitness can have serious consequences, especially as a person ages. Without flexibility, everyday tasks, such as sweeping the floor or even getting out of bed, become difficult. A reduced mobility of joints increases the risk of injury during an exercise routine, as well as the risk of occasional and chronic back pain. This chapter will provide a greater understanding of this vitally important component of a complete fitness program and demonstrate why flexibility shouldn’t be overlooked.

**Types of Flexibility**

Flexibility is classified into two types: static and dynamic.

* *Static flexibility*

This type of flexibility is a measure of the limits of a joint’s overall range of motion. It is measured by stretching and holding a joint in the position of its maximum range while using a measuring instrument to quantify that range. To achieve the maximum range, **passive forces**, the force generated from an external source, are required.

* *Dynamic flexibility*  
  This type of flexibility is a measure of overall joint stiffness during movement. Unlike static flexibility, dynamic flexibility requires active force production, or your own muscles contracting. Because quantifying “stiffness,” is difficult, dynamic flexibility is measured more subjectively. Assessment is based on how easy or difficult it is to perform certain tasks, such as swinging a tennis racket, climbing steps, or getting in and out of a car.

The aim of any good stretching program is to improve both static and dynamic flexibility so that normal ROM can be achieved. The definition of *normal* in this context is one developed from population studies that measured various areas of the body and established an average degree of movement for a particular joint.

# Benefits of Flexibility and Stretching

Regular stretching provides many benefits, the most important of which is simple: flexibility provides freedom of movement and the ability to complete activities with greater ease.

## Healthy Joints and Pain Management

As many as 26 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.2 For adults, arthritis is one of the most common conditions, with 54% of people 75 years and older having been diagnosed with arthritis.3 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.

Imbalances in the muscles can cause discomfort and pain. For example, if the front of a person’s thighs and hips gets 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 posture and can eventually lead to pain and stiffness in the neck, shoulders, and lower back. Stretching all major muscle groups and joint areas regularly 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, which is painful menstruation. It also relieves muscle cramps that can occur during exercise or participation in sports.

## Other Benefits

In addition to the benefits listed above, research has documented additional benefits that provide good reasons for maintaining a 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 helps them recover from exercise faster.4
* *Reduced risk of developing future lower back pain*Although research is still inconclusive, most experts agree that muscle fitness and stretching exercises reduce the risk of developing lower back pain by counteracting the natural loss in muscle and connective tissue elasticity that occurs with aging.

## Flexibility and Aging

For many college students, maintaining long- term flexibility is not a concern. For young adults, bending over to tie their shoes is painless. Walking around campus with a backpack requires minimal effort. However, ROM declines with age. Simple activities like rotating the head and neck to glance over the shoulders, getting in and out of a vehicle, or carrying groceries can become painful. Therefore, flexibility is critical in maintaining a high quality of life throughout the aging process.

## The Inactivity-Mobility Cycle

Anyone who has suffered an injury and had to wear a splint, cast, or brace to immobilize a joint knows how important mobility is to overall health. Unfortunately, when the joints’ ROM becomes restricted by arthritis or other injuries, activity declines. As activity declines, the ROM continues to diminish as a result of inactivity, and a vicious cycle ensues. A simple stretching program can help alleviate this problem and break the cycle.

# Improving Range of Motion

Joint ROM results from a combination of factors, which are classified as either internal or external. Internal structures relate to the physical structures of body materials and tissue. External factors are non-structural and include gender, age, excess fat mass, muscle mass, environmental temperature, 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 defined as a location on the skeletal system where 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 its ROM. For example, the shoulder joint, which is structurally a ball-in-socket joint, can rotate in multiple directions, giving it 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, ROM may be limited by excessive fat mass or even large muscle mass surrounding a particular joint. Although the amount of muscle mass and fat mass surrounding a joint can be altered by diet and activity levels, joint structure is permanent. As a result, little can be done to improve flexibility in this area.

Not only is range of motion related to the joint structure, but flexibility exercises are joint-specific. Stretching the hamstring will not improve flexibility in the shoulders. Likewise, flexibility in the shoulders may be excellent while fingers or ankles remain “stiff.” As such, a complete and effective stretching program includes multiple stretches for various joints.

## Connective and Muscle Tissue

Joints are surrounded and connected by muscles, tendons, ligaments, and skin. The head of the humerus fits into a small cavity to create the shoulder joint. However, those bones cannot remain in that position without the muscles, tendons, and ligaments that keep the joint tight and hold it in place. In addition, muscle tissue is surrounded with connective tissue, primarily collagen and elastin. As a joint moves through its 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 is not well understood, they do 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). Stretching that spring composed of soft tissues will change its 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. Experts suggest that a slow, sustained stretch for 30–90 seconds is necessary to produce chronic plastic deformation.

## Neuromuscular System

Modern cars come equipped with a central computer and sensors to troubleshoot problems with the vehicle. Sensors in the engine monitor temperature. Sensors on the wheels gauge tire pressure while sensors in the gas tank alert the driver when fuel is low. Much like a 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 (GTOs).

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, it sends signals to the central nervous system causing the stretched muscle to contract. This resistance to the stretch, called the **myotatic** or **stretch reflex** is generated by the nervous system’s reflexive stimulus sent to the stretching muscle. That same signal also causes the antagonist, or opposing muscle to relax, called **reciprocal inhibition**. As such, when the upper thigh (quadriceps) are stretched, the hamstrings (antagonist to the quadriceps) relax.

The GTOs are located near the **musculotendon 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, these signals 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, to effectively stretch, movements must be sustained for long, slow increments of time. Otherwise, the resistance encountered from the stretch reflex will not be overridden and lengthening cannot occur. Whether signaling the muscles to contract or relax, the neuromuscular system manipulates the stretched muscle, presumably as a protective mechanism to prevent injury.

# Improving Flexibility

Research has identified multiple stretching techniques that aid in improving ROM. Regardless of the specific technique or specific mode used, each technique can be performed using either active or passive mode. **Active stretching**, also called unassisted stretching, 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 described below.

### Static Stretching

The technique most commonly prescribed and used to improve 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’s 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 performing Yoga routines or stretching after a workout or an athletic event. Some of the major advantages of static stretching are as follows: 1) It is generally considered safe (see [Stretches to Avoid](#_Stretches_to_Avoid)); 2) It is simple to perform; and 3) It is effective at increasing ROM. The only major disadvantage comes from doing it too much, which can reduce strength and may make joints unstable. Of course, this potential risk applies to all of the techniques.

### Ballistic Stretching

Ballistic stretching involves forceful bouncing or ball-like movements that quickly exaggerate the joint’s 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 the forceful nature of ballistic movements, the muscular contraction from the stretch reflex may cause muscle soreness or even injury. For that reason, many coaches regard ballistic stretching as unsafe. Also, many researchers contend that it is less effective at improving ROM. Nonetheless, the American College of Sports Medicine (ACSM) still recommends ballistic stretching 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 do not 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 its ability to target and improve dynamic flexibility, which in turn may improve performance. A disadvantage comes from the movements involved, which often require good balance and coordination. Since mastering the correct form requires time and a certain level of athleticism, dynamic stretching may not be suitable for certain populations.

**Proprioceptive Neuromuscular Facilitation (PNF) Stretching**

This type of exercise usually involves a partner. The partner will passively stretch the person’s muscle. This movement is 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 contraction, 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 responses: the stretch reflex and the reciprocal inhibition (the relaxing of the antagonist muscle). After 5 seconds, the GTOs then override the muscle spindle’s signals causing autogenic inhibition. Because the muscle is relaxed, it can be stretched more easily. To reiterate, the stretch either uses the activity of the antagonist muscle to get the target muscle to relax or the target muscle itself relaxes as a result of the contraction of the antagonist muscle.

While many experts assert 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 are that it generally requires a knowledgeable partner, it is somewhat complicated, and it can cause soreness as a result of the contractions.

**Creating an Effective Stretching Program**

The ACSM has made specific recommendations on how to design a flexibility program (click [here](http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance) to view). However, before examining these recommendations in depth, you should first evaluate your current flexibility status by assessing various joints’ 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.

## Setting Goals

Once you determine which of your joints are the most and least flexible, you can set 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,” identify 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 is, “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 achieving it.

## Applying the FITT Principle

As mentioned previously, the ACSM has made recommendations for designing a flexibility program based on the FITT Principle (**F**requency, **I**ntensity, **T**ime and **T**ype). As the ACSM recommends, your flexibility program should include multiple stretching exercises that target all major joints, including the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles.

After selecting your exercises, follow the recommendations below when performing your routine:

* FrequencyStretch a minimum of 2-3 days per week, ideally 5-7 days per week.
* IntensityStretch to the point of tightness or mild discomfort.
* Time (duration of each stretch)Stretch for a minimum of 10 seconds for very tight muscles with an emphasis on progressing to 30-90 seconds. Complete two to four repetitions of each stretch.
* Type (mode)Select the technique that best suits your circumstances: static, dynamic, ballistic, or proprioceptive neuromuscular facilitation.

## When to Stretch

Although stretching can be done any time, the ACSM traditionally recommends that flexibility training be incorporated into the warm up or cool down phase of an exercise session. Recent studies suggests that stretching before an exercise session will compromise the force-producing capabilities of muscles and should be avoided. Therefore, it is recommended that stretching be restricted to *after* the warm-up or workout, when the temperature of the body and muscles has increased. Additional evidence pertaining to this concept shows that applying heat packs for 20 minutes to increase muscle temperature can increase hamstring flexibility more so than 30 seconds of static stretching. These findings confirm that temperature also plays a significant role in muscle ROM.

Additional information about improving your flexibility and balance can be found by clicking on the link below:

[Improving Flexibility and Balance](http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance)

## Stretching Safely

In addition to warming up your muscles before performing stretching exercises, additional precautions can be taken to ensure the safety of your routine. 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 previously, 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.

### **Stretches to Avoid**

Research indicates that some stretches are **contraindicated**, which means they are not recommended because they provide little to no benefit and may cause injury. A list of stretches to avoid, as well as safer, alternate stretches, can be found by clicking on the link below. However, this is not a comprehensive list of potentially risky stretches. To avoid injury, it is important to consider personal limitations before performing a stretch exercise.

[Contraindicated Stretches](http://www.mhhe.com/socscience/hhp/otw/fit_well/web12/Web12_IPT_Bad_Exercises_Flex.htm)

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# Assessing Your Flexibility

# Laboratory Exercises

The first step in creating a successful flexibility program is to assess your own flexibility. Follow the link below for instructions on how you can perform these assessments. The sections you may find most helpful include sections 5.1, 5.2, and 5.3.

[Assessment Exercises](http://wps.aw.com/bc_hopson_health_2/214/54825/14035385.cw/index.html)

**Terminology Checklist**

**Static Flexibility**: the outermost limit of a stretched muscle measured while holding a stretch in place. This can also refer to a technique used to improve the outermost limit of a stretched muscle performed by holding stretches for 15-60 seconds.

**Dynamic Flexibility:** the relative degree of ease a muscle can move through a normal range of motion. The can also refer to a technique used to improve static flexibility and ease of motion done by performing exaggerated movements.

**Elasticity:** the ability of the muscle to return to its resting length after being stretched.

**Plasticity:** the tendency of a muscle to assume a greater length after stretching.

**Proprioceptors:** sensors within muscles that send feedback to the central nervous system conveying muscular length and tension. The two primary sensors related to flexibility are Golgi Tendon Organs (GTO’s) and muscle spindles.

**Joint Structure:** the fixed arrangement of a joint that is a determining factor for range of motion. An example would be ball-in-socket joint or modified hinge joint.

**Myotatic Reflex:** a reflexive stimulus of the muscle to contract as a muscle is being stretched.

**Reciprocal Inhibition:** the principle that when one muscle is stimulated to contract the opposing muscle is will relax.

**Autogenic Inhibition:** an inhibitory reflex that allows one sensor in the muscle to override the signals of another sensor. Also called the inverse myotatic reflex.

**Active stretching:** a mode for stretching that is unassisted or involves no internal stimulus.

**Passive stretching:** a mode for stretching that uses an external source such as a partner or gravity to assist in the movements.

**Ballistic stretching:** a technique used to improve range of motion performed by gently bouncing back and forth to stretch and relax the muscle.

**Proprioceptive Neuromuscular Facilitation (PNF):** a technique used to improve range of motion performed by a sequence of stretching and contracting muscles. These sequences target the neuromuscular structures to facilitate relaxation of reflexive activity.

**Test Your Knowledge**

1. Experts, such as the American College of Sports Medicine, recommend performing flexibility exercises:
   1. A minimum of 2-3 days p/week
   2. At least 1-2 days p/week
   3. Ideally, 5-7 days p/week
   4. Both a and c
2. The best time to perform stretching exercises is:
   1. After a warm-up or after a workout session
   2. Immediately before all high-performance activities.
   3. To the point of pain
   4. While holding one’s breath.
3. The technique of stretching that emphasizes contracting followed by relaxing a muscle is called:
   1. Ballistic
   2. Dynamic
   3. PNF
   4. Passive
4. The key objective of performing flexibility exercises is to:
   1. Increase elasticity and plasticity of the muscles
   2. Improve body composition
   3. Release toxins that accumulate in the blood
   4. Improve lung capacity
5. The stretching technique most often recommended by experts for general fitness is:
   1. Dynamic
   2. Ballistic
   3. PNF
   4. Static

Key:

1. D
2. A
3. C
4. A
5. D

## **Sources**

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**Additional Readings**

Biomechanics of Stretching

<http://medind.nic.in/jau/t06/jaut06p3.pdf>