

Stretching for Dancers

by the International Association for Dance Medicine and Science

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This paper is intended to provide information on stretching, more formally known as flexibility training. It will discuss briefly the different types of stretching, along with their advantages and their disadvantages. It will also provide practical applications to the dancer: when to stretch, which tissues to stretch, how much and how often to stretch, as well as information on age and gender differences.

Flexibility Versus Range of Motion

Range of motion (ROM) is the degree of movement that occurs at a given joint. It is determined by each joint's unique anatomical structure and the movements required at that joint.¹ This anatomical structure provides stability and structure to the body, and allows for everyday movement. The ROM is determined by a number of anatomical, biomechanical and physiological factors such as shape of bones involved, the connective tissues (joint capsule and ligaments) which stabilize and restrict joint movement to a safe range, muscle mass and neurological tissue.

Flexibility is the ability of the soft tissue structures (muscles, tendons and connective tissue) to elongate smoothly and easily through the available ROM.² Flexibility is divided into two components, dynamic and static flexibility. Simply expressed, dynamic flexibility is the available active range of motion (AROM)—the body's ability to move the joint by contracting muscles. Static flexibility is the total movement achieved during a passive movement—an external force producing movement without the muscle contracting.^{3,4} For example, a dancer's dynamic flexibility is exhibited in the height of a *grand battement*. Static flexibility is demonstrated when a dancer uses a hand to pull the passive leg up further than the maximum height of the *grand battement*. While both are important components of flexibility, static flexibility is important in injury prevention since it is the amount the muscle can stretch when an external force is placed upon it.²

Types of Stretching

There are several different techniques for stretching muscles including ballistic, dynamic, static and

Proprioceptive Neuromuscular Facilitation (PNF). Each type of stretch has advantages and disadvantages, as described in the scientific literature. They are all effective at increasing range of motion; however, some of them are better than others, either for effectiveness, or to reduce the risk of injury. There are numerous research articles that compare short-term and long-term gains in flexibility from using the various types of stretch.⁵⁻¹⁰ Dancers should experiment carefully under the direction of experienced teachers or health care professionals to find the optimal stretching technique for their physique.

Ballistic Stretch

Ballistic stretch consists of repetitive bouncing, or using the swinging momentum of the trunk or limb, to provide a stretch force. The end position of the stretch is not held.¹¹ Dance involves many ballistic movements. For example, a *grand battement* involves a ballistic stretch of the hamstrings. Similarly, swinging the trunk toward the front of the thighs and then bouncing to touch the floor is also ballistic stretching of the hamstrings.

Ballistic stretching can increase flexibility in the short-term.² However, the problem with ballistic stretching is that it is not well controlled, so it is easy to exceed the extensibility limit of the soft tissue. These movements should only be performed when the dancer is well warmed up or they could potentially cause an injury to muscle tissue, tendon or muscle connective tissue.^{12,13}

Sensory receptors throughout the muscle, tendon and connective tissues constantly inform the central nervous system of joint position, pressure, temperature and forces sustained by muscles and tendons. The stretch receptors that detect changes in skeletal muscle length are called muscle spindles, due to their microscopic shape. The more rapid the stretch is, the greater is the spindles' firing back to the central nervous system. This, in turn, causes a reflex contraction of the stretched muscle as a safety mechanism to protect the muscle from injury. During a ballistic stretch, the fast stretch rate produces a high muscle tension and requires more of the stretch energy to be absorbed by the muscle at the end of the motion.¹³ Consequently,

muscle spindle activation causes the muscles to react to a rapid stretch by tightening rather than relaxing.

Dynamic Stretch

Dynamic stretch is often confused with ballistic stretch; however there are some important distinguishing factors. Dynamic stretch is a controlled stretching exercise that uses dance-specific movements to prepare the body for activity. These stretches emphasize the movement requirements of rehearsals, classes and performances. As an example of dynamic stretching, a controlled *développé* to the front or side dynamically stretches the hamstrings as it reaches maximal height. Advantages of dynamic stretching are: it promotes dynamic flexibility; it involves multiple joints; it replicates movement patterns that are required during dancing; it provides neuromuscular training to improve coordination;¹⁴ it strengthens the contracting muscle; and it keeps the core body temperature elevated so that muscles and surrounding tissues remain pliable.¹

Dynamic stretching is not as effective as static stretching for producing long-term gains in muscle length and flexibility, but it serves a purpose in getting the body ready for activity. Dynamic stretching should be performed only after a proper warm-up (elevated body core temperature indicated by a light sweat). Dynamic stretching should start slowly and gradually increase in the speed and power of the movement.

Static Stretch

Static stretch involves elongating the muscle to its tolerance. Once in the stretch position, remain in that position for 30 seconds, then relax. Each stretch should be repeated three to four times.¹⁵ Static stretches should never create a sharp or painful feeling. As one relaxes into the stretch, there may be a very slight lengthening of the muscle (stress-relaxation),¹³ but there is no rapid limb movement as in ballistic stretch. The stretching force is often created by gravity acting on the body, but the force can be generated by another external force such as a wall, the floor, the barre or a friend. This force is applied in a slow and steady manner, and it is important to continue regular breathing throughout the stretch. Static stretching is gentler than ballistic or dynamic methods, so it is less likely to cause muscle, tendon or muscle connective tissue tears or strains.^{1,13,16}

There have been numerous scientific studies to determine how long a static stretch should be held.^{14,17-19} It is recommended that the stretch be held for 30 seconds. It provides sufficient time for the muscle to relax, but probably not enough time to produce permanent

connective tissue lengthening (see “How Long to Stretch” below). There are short-term gains in flexibility and decreases in muscle resistance to stretch when using a 30-second static stretch, but these adaptations disappear quickly (within one hour).¹⁹ If the stretch is used consistently, flexibility gains can be maintained.

Prolonged Stretch

Prolonged stretch is very similar to static stretch, in that the stretch is held without moving. However, it is held for a significantly longer period of time, several minutes instead of seconds.^{20,21-24} These stretches are used by medical professionals for very specific and serious medical pathologies and are not appropriate for dancers. They elongate anatomical structures that are supposed to stabilize the joints, i.e. ligaments and joint capsules. Dancers should avoid these stretches as they can lead to loss of stability and serious injury (See “Which tissues to stretch”).

Dancers frequently use these stretches (either intentionally or unintentionally) when they sit on the floor between classes or while doing homework, maintaining their legs in various stretch positions for long periods of time. For example, lying forward while in second position for extended periods places undue compression of the hip labrum, potentially contributing to future injury.

Proprioceptive Neuromuscular Facilitation (PNF)

PNF techniques were developed by physical therapists in the 1950s to treat patients who were weakened by diseases such as polio.^{25,26} These techniques have now been modified (straight planes versus diagonals) for use in athletes and dancers. There are many types of PNF stretching techniques; each technique has three phases with variations on contracting and relaxing opposite muscle groups.

PNF techniques are effective for producing short-term increases in flexibility;^{5,6} however, it takes some skill and creativity to perform them correctly. As they do present risk of injury, they should only be undertaken under the guidance of a health-care professional.

When to Stretch

Stretching is not the same as warming up. The purpose of a warm-up is to increase the temperature of the core and muscle tissue. An indication that the body temperature has increased is a slight sweat appearing on the skin. The time prior to class should not be used to increase flexibility. Warm muscles are more extensible and responsive, so it is far better to stretch immediately AFTER class or rehearsal when muscles have been exercised for 1-2 hours. Research

has shown that applying a small amount of stretch force to warm connective tissues lengthened them more effectively than larger stretch forces (four times larger) applied to the same tissues at normal body temperature.²⁷ Long-term retention of tissue length lasted more than twice as long when the low-load stretch was applied to warm tissue. Additionally, stretching with higher tissue temperatures, as seen following class or rehearsal, resulted in fewer injuries.²⁷ Holding the stretch while cooling down allows even greater increases in tissue length to be achieved.²⁸

Even when warm, it is not advisable to do major stretching before a demanding class, performance or rehearsal. Stretching has been shown to impair subsequent performance parameters, such as strength,^{29,30} power,³¹ endurance,³² balance,³³ grip strength,³⁴ sprint time,³⁵ jumping height,³⁶⁻³⁸ reaction time and movement time.³³ Probably of most concern to dancers, the magnitude of the jumping deficit is 5-30%,³⁹ accompanied by a decrease in ankle plantar-flexion strength (25% decline straight after a 30 minute stretch).^{30,39} The deficit in jump height does not differ amongst short stretch durations;⁴⁰ however, longer duration of stretch seems to cause progressively more impairment in jump height.³⁸ Jump height decrement was shown to be greatest at 28% straight after a 30 minute stretch. It significantly declined as stretches shortened, to a 4% decrement after a 30 second stretch.^{37,40-42} However, even a 15-30 second stretch can cause a decline in muscle force.⁴⁰ These changes within the muscle during a stretch are thought to be both mechanical and neurological.³⁰ Mechanically, a stretched muscle may not transmit force as effectively to the bones.⁴³ Neurologically, a recently stretched muscle may exhibit less activation of the stretch reflex of the muscle's contractile force.^{44,45} Certain positions of stretch compromise nerves more than others, and subsequently interfere with muscle activation. A sign of nerve compromise is a feeling of pins and needles in the toes or fingers during a hamstring stretch or a shoulder stretch, respectively, and stretches that elicit these symptoms should be avoided, especially prior to performing demanding choreography where fine control is important.

Luckily, the detrimental effect of stretching on subsequent muscle performance dissipates over time. The neural activation recovers approximately 15 minutes after a static stretch, but the muscle properties may not recover for up to one hour after a they have been stretched for 30 minutes, according to some researchers.³⁰ Additional activity between stretch and performance has NOT been shown to prevent these stretch-induced problems,⁴⁶⁻⁴⁸ but this question is still a topic of current research. The effects may also be less detrimental in trained athletes than in

untrained recreational athletes.⁴⁹⁻⁵¹ There are no gender differences in these performance deficits.⁵¹

In summary, it is safe and effective to move through the body's normal range of motion before class, rehearsals and before performances. Brief stretches of less than 15 seconds are unlikely to cause performance problems. Dynamic stretches, such as dance movements, are less detrimental to performance than static stretching.⁴⁵ If increasing flexibility is a goal, it should occur over time (at least six weeks) and should occur following class, rehearsal or performance when the muscles are already warm and more likely to make permanent changes to increase flexibility. Research in this area is likely to continue to evolve as we learn more about the effects of stretching and performance.

Which Tissues to Stretch

Stretching is useful for increasing the flexibility of muscles and their associated connective tissues (fascia). The connective tissues in muscle include the muscle cell membrane (sarcolemma), the covering around individual muscle fibers (endomysium), the covering around and between bundles of muscle fibers (perimysium) and the covering around the whole muscle (epimysium). Although some resistance to stretch comes from stable bonds between the muscle's contractile filaments (actin and myosin),⁵² the majority of the resistance to stretch comes from these fascia layers.^{53,54} In order to increase the length of the muscle, thus increasing the flexibility, these connective tissues need to be stretched.

Tendons connect the muscle to bone, producing a lever system within the body to cause movement. They are made up of connective tissue; however, they are bundles of dense connective tissue, which do not stretch as easily as the loose connective coverings surrounding the muscle. Therefore, most of the changes from stretching occur in the muscle itself and the fascia surrounding it, and not in the tendon.⁵⁵

Conversely, it is important NOT to "stretch" (elongate) ligaments and joint capsules. Ligaments and joint capsules are intended to provide stability to the joints. If ligaments and capsules are healthy (not injured), they are the correct length for this purpose. "Stretching" these tissues can permanently elongate them, making a joint hyper-mobile and less stable.⁵⁶ Less joint stability requires muscles to work harder to hold the joint in a stable position, thus making the joint's movement properties less efficient. For example, the fibular (peroneal) muscles may need to work harder to stabilize an ankle that has become unstable after being over-stretched through repetitive sprains.⁵⁷

How Much to Stretch

Every dancer's body is different. Some dancers are inherently less flexible. Dancers with "tight" bodies are built for stability, with dense connective tissues. Their muscles are less extensible.⁶³ Conversely, some dancers are innately more flexible. The hyper-mobile physique has an increased risk of injury.⁵⁸⁻⁶² They have a larger joint range of motion, but they are also more vulnerable to serious ligament sprains.^{63, 64} Hence "loose" dancers should spend less time stretching than "tight" dancers. Loose dancers should spend that time on strengthening exercises instead. It is important to avoid comparing the flexibility of one dancer with that of other dancers. Instead, work on what each individual dancer needs – strengthening/stabilizing exercise for the loose dancer, stretching/flexibility for the tight dancer. When stretching, it is vital to not push the body too hard. Pushing stretches too hard may cause a muscle strain (tear), so is important to be cautious. Stretches should be held to a point of mild discomfort, not pain.

How Long to Stretch

Holding a static stretch for 30 seconds is enough to maintain joint range of motion and current flexibility. Typically, each stretch is repeated 3 to 5 times in a single stretching bout. But, if increasing flexibility is the goal, then deformation of the connective tissue is necessary to produce permanent muscle length change. When trying to increase flexibility, it is important to employ stretching AFTER dancing or other activity when muscles and connective tissues are warm. Avoid stretching structures that shouldn't be stretched (see above "Prolonged Stretch" and "Which Tissues to Stretch").

How Often to Stretch

The benefits gained from a single bout of stretching last for a brief period of time, approximately five minutes. In contrast to a single bout, a multi-week program of stretching creates benefits that last for several weeks after stretching is discontinued.⁶⁴⁻⁶⁶ Stretching just once a week is sufficient to maintain current flexibility.⁶⁷ Other research showed that increasing the frequency of stretch from once per day to three times per day did not increase range of motion.⁶⁸ Additional benefits can be gained by doing up to four repetitions within a bout of stretching.¹³ There appears to be little benefit in doing more than four repetitions of stretch per bout.

Age and Gender Issues

In general, females are more flexible than males at the same age.⁶⁹ While it may not be desirable to make males as flexible as female dancers, male dancers need to develop enough flexibility to prevent injuries.

The most comprehensive study of childhood flexibility was performed on 4,500 Baltimore (USA) school children, ages 5-18 years.⁷⁰ Boys and girls performed two flexibility tests: sitting reach for toes and sitting head to knees. For each age, Kendall recorded the percentage of children who could successfully perform each test. On the sitting reach (sitting with knees straight and reaching fingers toward toes), 100% of 5-year-olds could do it. However, by age 12, only 30% of children could do so. The low point in flexibility occurred at age 12 for boys and age 13 for girls. Flexibility then increased again, with approximately 60% success on this test in 18-year-olds. Graphs of more detailed results, with each gender plotted separately at each year, are available in the article for the interested reader. (On the forehead to knees test, very few children of any age could perform the test, unless they had dance or gymnastics training.)

Why is there a loss of flexibility in children of both genders, with minimum flexibility being reached at 10-12 years?⁶⁹ This age coincides with the skeletal growth spurt, so muscle tissues are shorter relative to bone length until muscle growth catches up to bone growth. Dance teachers need to recognize that young dancers will go through a phase of apparent loss in flexibility. During this time there is also an increased chance of injury to muscles.⁷¹ The age at which this occurs in dancers may be different from non-dancers, since female dancers may have delayed onset of puberty. Additionally, age at puberty has also changed in the 60 years since Kendall's study, tending to occur earlier now.

At the other end of the age spectrum, aged adults also become less flexible with the passing years. Allander et al. found that males lose 1.8 degrees of hip motion and 2.2 degrees in shoulder and wrist motion every five years.⁷¹ These age-related flexibility losses are likely to be because the connective tissue loses elasticity.⁵⁶ There is reduced maximum tensile strength (resistance to stretching before tearing), and the rate of adaptation to stress is lower with age.⁷²

This paper is dedicated to the memory of Marjorie Moore, Ph.D.

Stretching for Dancers – Summary

Ballistic stretch: A brief, bouncing, swinging stretch

- Advantage – useful for coordination
- Disadvantage – high risk of injury

Dynamic stretch: Controlled, dance-like movements that prepare the body for activity

- Advantage – improves coordination without risk of injury
- Disadvantage – not as effective as static stretch in producing long-term gains in flexibility

Static stretch: Held for 30 seconds

- Advantage – useful in maintaining flexibility
- Disadvantage – needs to be regular to produce long-term gains in flexibility

Prolonged stretch: Held for 20 minutes or more

- Should be avoided

PNF (Proprioceptive Neuromuscular Facilitation)

- Advantage – effective in producing long-term flexibility over time
- Disadvantage – needs professional guidance to avoid risk of injury

When to stretch

- DO stretch after class when muscles are warm
- DO NOT stretch preceding performance or a major rehearsal, due to detrimental effects on jumping

What to stretch

- DO stretch muscles and their connective tissue (fascia)
- DO NOT elongate ligaments and joint capsules

How long to stretch

- Three to five bouts of 30 seconds static stretches are sufficient to stretch muscle tissue

How much to stretch

- Depends on your body
- “Tight” dancers need to stretch more than “loose” dancers
- Increasing “loose” dancers’ hyper-mobility can reduce their joint stability

How often to stretch

- Once a week to maintain joint range of motion
- Three to five times per week to increase range

Gender issues

- Females are generally more flexible than males of similar ages

Age issues

- Children become less flexible during their skeletal growth spurt
- Adults become less flexible with increasing age

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