THE SCIENTIFIC RATIONALE FOR STRETCHING

Presented by The National Academy of Sports Medicine

Content Derived from NASM's Corrective Exercise Specialization: nasm.org/ces

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CORRECTIVE EXERCISE FOREWORD

This course was derived from a chapter in NASM's Corrective Exercise Specialization (http://www.nasm.org/ces).

Corrective Exercise is a technique used to determine the root cause of imbalances and faulty movement patterns that lead to issues with posture, balance, and total body coordination.

Once the issue or issues are identified, a Corrective Exercise Specialist can then develop an exercise routine that addresses the problem through individualized flexibility and strengthening exercises.

By addressing a client's functional movement and the issues impeding it, especially at their major joint structures, corrective exercise helps the body to manage everyday loads by encouraging proper alignment. This may help reduce the risk of future injury.

INTRODUCTION

This course will give you an overview of the science and rationale for stretching - and why it is an essential aspect of corrective exercise and optimal human movement.

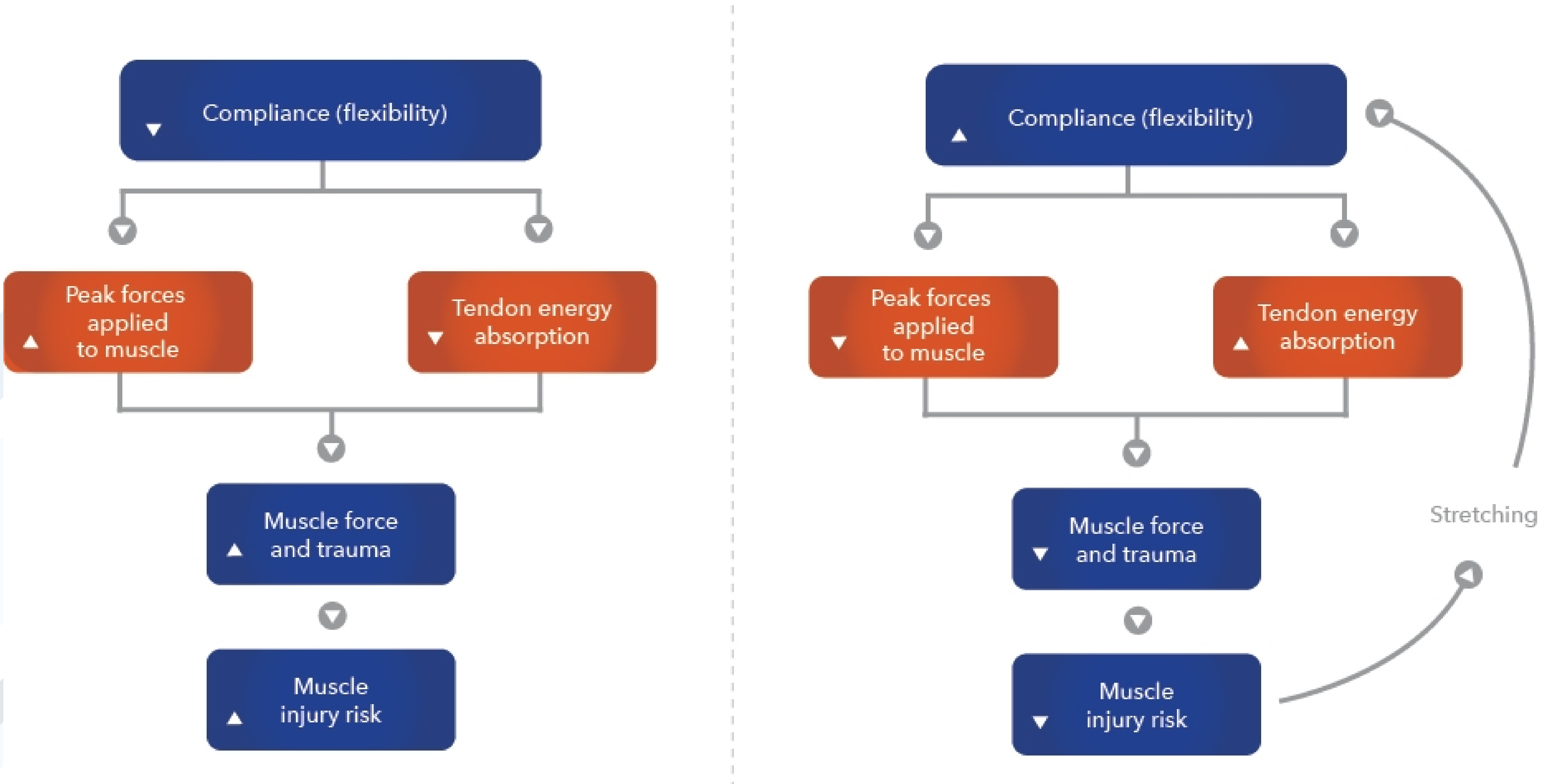
Because it's easy to assume to look at stretching as "optional", the purpose of this course is to highlight the relevant science-based reasons to approach stretching as an important discipline. To offer you the most salient points about stretching, this paper is divided into a few sections:

- Injury prevention mechanism through stretching
- Stretching to improve range of motion (ROM)
- Duration and frequency considerations
- Intensity – finding a sweet spot
- Athletic, strength, and performance benefits

INJURY PREVENTION

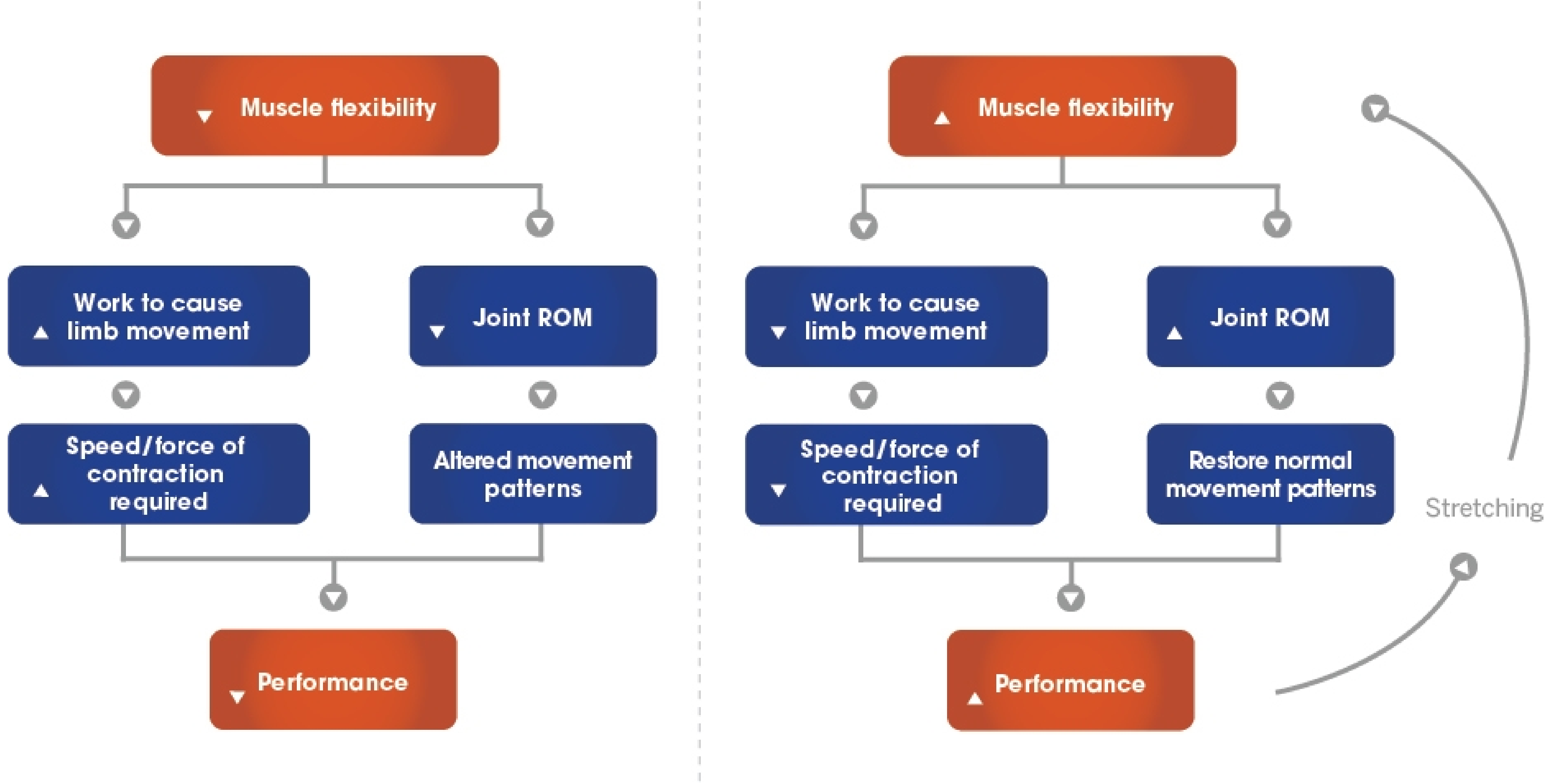
Stretching is a powerful technique because it helps create fluid movement through a full range of motion. Stretching helps increase joint range of motion because it increases the extensibility of muscles, tendons, and connective tissue. Remember, muscles connect to bone via tendons, and both are surrounded by fascia (a sticky connective tissue) that provides structure and support. However, these structures can become stiff resulting in limited range of motion and faulty movement patterns.

As shown in the diagram below, the compliance (or flexibility) of the musculotendinous unit (the area in which muscle turns into tendon) affects the relative amount of energy absorbed by the muscle and tendon:[1]



1. Safran, Garrett, Seaber, Glisson, & Ribbeck, 1988

Or in other words, increasing musculotendinous flexibility through stretching will lead to a decrease in peak muscle energy absorption and trauma to muscle fibers, with a decrease in muscle and tendon injury risk being the potential result (see the diagram below).



When it comes down to it, decreasing muscle stiffness through stretching will decrease the work required to perform a particular activity and potentially increase overall performance.

- High stiffness (↓ flexibility) → ↑ Resistance to Motion = ↑ Work required
- Low stiffness (↑ flexibility) → ↓ Resistance to Motion = ↓ Work required
- ↓ Flexibility limits joint range of motion

IMPROVE RANGE OF MOTION

Limited flexibility can create dysfunctional movement. It also means an individual will have to expend more energy than if they were limber. Muscle stiffness also leads to less range of motion (ROM). As stated before, stretching can decrease muscle stiffness, which means less work (effort) to perform certain movements. This lack of stiffness also leads to a greater range of motion – resulting in smoother, more efficient movements. As stated before, stretching can decrease muscle stiffness, which means less work (effort) to perform certain movements.

Stretching exercises are primarily used to increase the available joint ROM - specifically if the range at that joint is limited by tight myofascial (muscles and fascia) tissues. The scientific literature strongly supports the use of all stretching exercises to achieve this goal.[1]

The degree of improvement may be relative to the total available ROM at the joint. For example, the hip joint has greater range of motion capabilities than the ankles.

In comparison, the lower back has ranges of 20 to 30 degrees and 60 to 80 degrees for thoracolumbar extension and flexion respectively.[2] Therefore, while stretching is still important for areas such as the lumbar spine (low back), the gains in flexibility cannot be expected to be as great as for the hip or shoulders.

1. Alter, 1996; Behm, 2018; Behm et al., 2016; Behm & Chaouachi, 2011; Kay & Blazevich, 2012
2. Behm, 2018

CLIENT SPECIFIC EVALUATIONS

Several researchers suggest that each joint and muscle group may respond differently to stretching protocols; thus, each tissue to be stretched should be carefully evaluated and the stretching protocol may need to be different for each ROM limitation found.

For instance, a 6-week stretching program for the hamstring complex effectively increased ROM, but the same program applied to the gastrocnemius (calf) muscle did not result in a change of ROM.[1] Consequently, individuals should strive to find the right combination of stretching techniques that maximize increases in ROM. This requires identifying joints or movements with limited ROM and then reevaluating at a later date if the programmed stretching protocols have helped.

For example, an individual with limited ankle ROM (sometimes a result of tight calves), should implement a calf stretching protocol for several weeks and then reevaluate their ankle ROM.

1. Bandy & Irion, 1994; Bandy, Irion, & Briggler, 1997; Youdas, Krause, Egan, Therneau, & Laskowski, 2005

DURATION AND FREQUENCY

Most of the debate surrounding the use of stretching protocols has involved the necessary duration and frequency of stretching to produce a change in ROM.

For example, studies by Bandy and colleagues found that static hamstring stretches need to be held for 30 seconds and performed 5 times a week for 6 weeks to produce significant changes in knee extension ROM.[1]

The majority of other studies have found durations of 15 to 30 seconds can produce significant changes in ROM.[2]

To ensure significant improvements in ROM without adversely affecting strength and power performance, Behm and colleagues[3] recommend less than 60 seconds of stretching per muscle group within a single stretching session, while Thomas, Bianco, Paoli, & Palma[4], in their scientific review, recommend a minimum duration of 5 minutes per week for each muscle group.

1. Bandy & Irion, 1994; Bandy et al., 1997; Behm, 2018
2. Behm, 2018.
3. Behm, 2018; Behm et al., 2016
4. Thomas, Bianco, Paoli, & Palma 2018

OVERTRAINING

It is still unclear whether stretching should be performed daily or can be performed as few as three times a week to produce significant changes.[1]

And, more recently, a study by Caldwell, Bilodeau, Cox, and Behm[2] compared stretching once versus twice a day for 2 weeks. They did not find an increase in passive, static ROM, but found improvements with dynamic and ballistic range of motion, as well as strength and power (jump) improvements.

The aforementioned study suggests that possible overtraining can occur with excessive stretching frequencies, which may affect the lack of increases in static ROM, at least with recreationally active participants.

1. Bandy & Irion, 1994; Bandy et al., 1997; Ford, Mazzone, & Taylor, 2005; Godges, MacRae, & Engelke, 1993
2. Caldwell, Bilodeau, Cox, and Behm 2019

APPROPRIATE STRETCHING INTENSITY

Some studies[1] recommend stretching to the point of slight to moderate discomfort. This is also referred to as stretching to the elastic limit.

The elastic limit is the minimum amount of stress placed on tissue to elicit permanent strain. Going farther than the elastic limit could cause the tissue to not return to its original length[2] and, thus, contribute to strains (muscle and tendon injury) and sprains (ligament injury).

Conversely, a number of static stretching studies have demonstrated that stretching to less than the point of discomfort provides similar flexibility improvements as stretching to the point of discomfort.[3]

Research has suggested that high-force (i.e., stretching to the point of discomfort), shorter-duration stretches may emphasize elastic (short-term or temporary) tissue deformation, while low force (i.e., less than or near the point of discomfort), prolonged stretching emphasizes plastic (long-term or semi-permanent) changes in tissue length.[4]

TRAINING TIP: Stretching Intensity

While ROM will increase with short duration stretching (5 to 15 seconds), the recommended duration for each muscle to be stretched is 30 to 60 seconds. Stretch to the onset of the point of discomfort, but there is no need to elicit significant discomfort or pain. Instead, opt for a moderate stretch tension on the muscle. ROM can be improved within 2-6 weeks if performed 3 to 5 days per week.

1. 1. Behm, Bambury, Cahill, & Power, 2004; Behm et al., 2006; Behm, Button, & Butt, 2001; Behm & Kibele, 2007; Behm et al., 2011
2. Alter, 1996
3. Behm & Kibele, 2007; Knudson, Bennett, Corn, leick, & Smith, 2001; Knudson, Noffal, Bahamonde, Bauer, & Blackwell, 2004; Manoel, Harris-Love, Danoff, & Miller, 2008; Young, Elias, & Power, 2006.
4. Apostolopoulos, 2001; Laban, 1962; Sun et al., 1995; Warren, Lehmann, & Koblanski, 1971, 1976

BENEFITS

There is a common misconception that stretching reduces athletic performance and, therefore, should not be performed before taking part in athletic activity.

However, this is not necessarily the case. The body of research that has investigated changes in athletic performance caused by stretching protocols is not nearly as clear as the literature that supports beneficial changes in ROM caused by flexibility protocols.

The term athletic performance may encompass changes in muscular strength or power or in the performance of jumping, sprinting, or agility activities.

Reviews of static stretching and Neuromuscular Stretching research over the last 20 years suggested that, acutely, prolonged static or NMS stretching may have a detrimental effect on muscular strength, power, balance, reaction and movement time, as well as vertical jump height and sprint speed.[1]

Helpful Hint

Static stretching is performed by holding a stretched position for a prolonged period of time (e.g., 30-60 seconds). Neuromuscular Stretching is a form of partner assisted stretching in which a partner assists an exerciser during the stretching technique. Neuromuscular stretching has a specific protocol beyond the scope of this article. Dynamic stretching includes low-intensity activity and exercise such as arm circles, jumping jacks, hip swings, lateral tube walking, and push-ups.

The extent of performance impairment reportedly ranged on average from 3 to 7%.[2] This effect generally appears to last less than 10 minutes, but some studies have found that strength may be impaired up to one hour after the stretching protocol.[3]

1, 2. Behm, 2018; Behm et al., 2016; Behm & Chaouachi, 2011; Kay & Blazevich, 2012

3. Fowles, Sale, & MacDougall, 2000; Power, Behm, Cahill, Carroll, & Young, 2004

In general, to prevent performance impairments, it is recommended that static stretching should be performed for less than 60 seconds per muscle, whereas dynamic and ballistic stretching do not have the same effect.[1]

TRAINING TIP

A 1-minute duration is important for stretching. A person needs 20 to 60 seconds of stretching to elicit a change in tissue extensibility and it is noted that someone should not stretch more than 60 seconds per muscle group to ensure there are no performance impairments.

1. Behm, 2018; Behm et al., 2016; Behm & Chaouachi, 2011; Kay & Blazevich, 2012)
2. Baxter, McNaughton, Sparks, Norton, & Bentley, 2017

INJURY RESISTANCE

Many fitness professionals and athletes perform stretching as part of a routine warm-up before activity, prompted by the belief that stretching can prevent certain injuries. The evidence suggests that pre-exercise static stretching does not have a significant impact on all-cause injury risk or rates[1], although the effects of chronic, long-term static stretching protocols tend to lead to decreased muscle and tendon injury rates.[2]

There is confusion in the literature regarding the lack of static stretching effects upon all-cause injury risk versus muscle and tendon injury risk. All-cause injury risk can include problems like bone fractures, knee cartilage lesions, bursitis, overtraining injuries, and many other problems. Stretching cannot normally prevent a bone fracture, but, as mentioned earlier, it can increase muscle and tendon energy absorption capabilities, which can help decrease the high and rapid forces associated with sprinting and agility.

Several authors and researchers have shown that regular, long-term static stretching can lead to a decreased incidence of muscle and tendon injury (18 to 43% decreased rate) and decreased cost of time lost from injury, and fewer severe muscle/tendon injuries occurred in the stretched subjects compared with control subjects.[3]

1. Pope, Herbert, & Kirwan, 1998; Pope, Herbert, Kirwan, & Graham, 2000; Small, McNaughton, & Matthews, 2008
2. Hartig & Henderson, 1999; Andrish, Bergfeld, & Walheim 1974; Pope et al., 2000; Amako et al., 2003; Hilyer et al., 1990; Thacker, et al., 2004
3. Fradkin, Gabbe, & Cameron, 2006; Hartig & Henderson, 1999; Woods, Bishop, & Jones, 2007

Behm et al.[1] reported a 54% injury risk reduction of muscle and tendon injuries with static stretching. Behm and colleagues[2], in their review, recommend that pre-activity static and dynamic stretching of five minutes or more should be beneficial for sprint running injury prevention, but is less effective for endurance running activities (overuse injuries).[3] In all of the studies cited, there does not appear to be any negative consequences relative to injury risk when implementing a regular or pre-exercise stretching program.

4, 5. Behm et al. 2016

6. Baxter, McNaughton, Sparks, Norton, & Bentley, 2017

SUMMARY

As indicated by the aforementioned review of research and literature surrounding flexibility, the following guidelines have been determined:

- There is strong evidence to indicate that regular stretching of all types (static, NMS, or dynamic) improves ROM.
- There is a moderate level of evidence that dynamic stretching can positively affect strength and performance, whereas static stretching can decrease muscle and tendon injury risk in healthy individuals without identified limitations in flexibility.
- There is moderate evidence to indicate that acute, prolonged (> 60 seconds per muscle group), pre-exercise static and NMS stretching performed in isolation (i.e., without a complete warm-up) can decrease strength and performance by 3 to 7%. However, when placed within the context of a comprehensive warm-up, static stretching and NMS will have have a trivial chance of impairing subsequent performance and does not affect injury risk in healthy individuals without identified limitations in flexibility.

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