

# The Great Stretching Debate

By Tamara Mitchell  
Edited by Sally Longyear



After years of participating in sports and exercise of many types, and listening to coaches and fitness experts, we have had it engrained in us to warm up, stretch, exercise, cool down, and stretch again. But a very recent review of 361 research studies conducted by the epidemiology program office at the Centers for Disease Control and Prevention (CDC) concluded that there is no evidence that stretching before or after exercise prevents injury or muscle soreness.<sup>1,2</sup> Wow! Hard to believe, but true. And we even confirmed it with a qualified personal trainer.<sup>3</sup> It turns out that stretching has been controversial for a long time; some experts have not advocated stretching before, during, or after a workout for 20 years!

Medical and nutrition advice seems to take a 180-degree turn every time we tune in, so perhaps it's no surprise after all. It's hard to discredit the CDC review, since it included hundreds of studies, many of them testing hundreds or thousands of subjects. The review even weighted each study so weaker research received less consideration than rigorous studies. But, we still just couldn't believe it without doing some reading on our own. What type of stretching was studied? What type of exercise was studied? Is stretching actually bad, or is it just not helpful?

The CDC research review concluded that there isn't sufficient evidence to either recommend that people *stop* stretching, nor good evidence that people *should* stretch. Basically, if it feels good, continue to do it following exercise, but if you don't like stretching, put that time into warm-ups and balance exercises instead.<sup>2</sup> Keep reading to learn about the most effective warm-up and stretch routine.

## What stretching does and does not do

First, we need to preface our discussion about stretching. This article addresses stretching with regard to injury prevention during exercise. We still strongly encourage everyone to stretch during the workday to relax and lengthen tense muscles and improve circulation during rest breaks. The problem with working at a computer is that your body is held relatively rigid for a long time. Stretching will reduce the potential for Repetitive Strain Injuries associated with office and lab work. But this is very different from stretching when participating in exercise or sports.

Stretching does improve flexibility, but flexibility doesn't prevent sports injuries, as found in the CDC review.<sup>1,2,4</sup> Most injuries happen when the muscle is going through its normal range of motion, so having an increased stationary range of motion probably has no effect in preventing such injuries.<sup>2,4</sup> In fact, an increased range of motion at a joint can actually increase the instability of the joint. Some research has indicated that athletes who are in the highest 20% of the flexibility continuum are the ones with the highest injury rates.<sup>1,4</sup>

Certain types of flexibility, however, are important in sports such as gymnastics, diving, ice skating, and dance.<sup>1</sup> The best data indicate that performance might be lowered at the extremes of flexibility and that, at least for some muscle/joint groups, there might be optimal levels of flexibility that would enhance performance.<sup>1</sup> These benefits are likely to be specific to a sport or even to a specific body movement.<sup>1</sup> More research is needed to understand this relationship.

Most of the research looked at static stretching (i.e., long, slow stretches). It is already well known that ballistic stretching is very likely to cause injury due to bouncing and repeated rapid stretches.<sup>1,4,5</sup>

### **Warm-up is still important**

Research continues to recommend warming up prior to exercise.<sup>1,2,4,7</sup> Warming up reduces muscle stiffness rather than increasing range of motion.<sup>4</sup> Stiff muscles are very resistant to changes in tension and possibly much more susceptible to injury.<sup>4</sup> An active warm up also increases muscle temperature which enhances muscles' resistance to tearing. This increase in temperature can decrease stiffness and minimize the risk of muscle and tendon injuries during a workout or sport activity.<sup>4</sup>

Warming up consists of at least 10 minutes of exercise at a low level of activity. Replace stretches with dynamic activities that resemble the actions that are to follow in the workout or competition, gradually increasing intensity and eventually mimicking the intensity of the most strenuous moments of the activity. This prepares the neuro-muscular system for the workout ahead. For example, running at a modest intensity for 10 minutes has been found to be effective for reducing the active stiffness of leg muscles.<sup>4</sup> There may be optimal levels of warm-up related to fitness of the person involved, since fatigue has detrimental effects.<sup>1</sup>

Passive methods to increase body temperature (hot baths, moist heat) also tend to increase performance, but to a lesser degree and the effects of massage were not consistent.<sup>1</sup> There is no information on these methods with regard to reducing injury.

### **Good conditioning is best**

Research indicates that the best predictor of injury is how conditioned the person is. A person who is in better shape is less likely to get injured.<sup>4</sup> Conditioning also prevents muscle soreness after exercise. There is strong evidence that strength training, conditioning, plyometrics, proprioception (balance) training and warm-up play an important part in injury prevention.<sup>1</sup> But too much is not a good thing; higher injury rates are associated with overtraining. (e.g., high-mileage runners who have very long workouts have more injuries than low-training-volume runners.<sup>4</sup>)

Age appears to be a predictor of injuries as well; older people experience higher injury rates. However, age is *not* a good predictor of injuries among experienced, well-trained athletes.<sup>4</sup>

Another study demonstrating that fitness level is highly related to probability of injury found that an individual's 20-meter shuttle run time was a good predictor of injury. This assessment accurately predicts maximum oxygen capacity and running capacity.<sup>4</sup>

### **Stretching before exercise?**

The traditional theory of stretching before exercise is that it will limber up muscles and prevent injury. Studies with hundreds of subjects have been conducted with various controls and they seem to come up with similar results. Stretching before a rigorous workout (varying from

running, army basic training, to martial arts) has consistently been shown to have no significant effect on injury rates during exercise.<sup>1,4,5,6,8</sup>

If you try to make a fast, dynamic movement immediately after a static stretch you may injure the stretched muscles.<sup>5</sup> The more strenuous the stretch (closer to the pain threshold), the more likely the injury.<sup>5</sup> Even mild static stretching can damage muscle cells. Static stretching also increases pain tolerance.<sup>1,5</sup> With an increased tolerance to pain, it is not wise to exert the muscle immediately afterward in its anesthetized state.<sup>5</sup>

In addition, relaxed static stretches decrease strength by impairing activation of the stretched muscles for up to five minutes and contractile force for up to one hour.<sup>5</sup> Stretching has been shown to temporarily decrease muscle strength by 20% in both human and animal research.<sup>4,5</sup> Other research indicates that passive stretching in animals can reduce the force required to damage muscle by as much as 25-30%.<sup>4</sup>

Static stretching has very little resemblance to the rapid-fire muscle contractions during a workout (e.g., elongating your hamstrings does little to prepare them for the upcoming endurance required) and thus may have little chance of preventing injury.<sup>4</sup> In addition, dynamic range of motion is generally greater than static range of motion due to enhanced tissue elasticity and relaxation of opposing muscles when one muscle group is contracted.<sup>1</sup> Since most injuries are due to overuse, stretching does nothing to prevent injuries of this type.<sup>4</sup>

One study of males who ran the same number of miles per week found that those who stretched before training had a 33% greater risk of injury than the non-stretching runners.<sup>4</sup> This is true even after discounting the runners who had a high risk of injury due to a previous injury, and who might be stretching more as a result. Interestingly, it was found that the highest injury rate only applied to Caucasian males. Females had the same injury rate for stretchers and non-stretchers. Asian runners also had the same injury rates for stretchers and non-stretchers. The only weakness in this study is that it did not control for the type of stretching, so we don't know if the white males were perhaps more likely to rush stretching using ballistic stretches.

### **Stretching after exercise?**

The theory behind stretching after exercise is to relax tense muscles and help the body rid the muscles of lactic acid (a waste product that accumulates during exercise). First, and most conclusive, is the fact that lactic acid does not cause muscle soreness.<sup>7</sup> Blood and muscle lactate levels typically return to normal values after 30-60 minutes of recovery. The pain associated with delayed onset muscle soreness (DOMS) peaks after 24-72 hours, well after the lactate levels have returned to normal.<sup>7</sup>

Research has found that DOMS is most severe with eccentric exercise and less severe with concentric exercise.<sup>7,9</sup> Concentric exercise works muscles in pairs: when one contracts, the opposing muscle relaxes. Eccentric exercise involves motion where muscles are stretched as they attempt to contract. Examples of this are walking or running downhill, landing from jumps, performing squats, attempting to come to an abrupt stop at the end of a short sprint, slowly lowering a heavy object held in the hands, or plyometrics. Instead of initiating an action, the activated muscle acts as a brake to restrain action. This type of activity can result in muscle soreness.<sup>7,9</sup> If DOMS were caused by lactic acid build-up, it would be expected that muscle soreness would be higher from concentric exercise that requires greater energy expenditure where more lactic acid is produced. The opposite is actually true, where eccentric exercise has been shown to produce DOMS at little metabolic cost with less lactic acid production.<sup>7</sup>

What appears to cause DOMS is a breakdown of protein structures within the muscle.<sup>7,9</sup> In addition, inflammation and stiffening of the connective tissue matrix causes activation of pain receptors, resulting in DOMS.<sup>7,9</sup> Finally, the slow release of substances such as bradykinin, histamine, and prostaglandins by damaged cells stimulate and sensitize pain receptors.<sup>9</sup> After eccentric exercise that causes proteins to break down, the body builds new muscle fiber to make protein structures even stronger and more resistant than before.

The study noted in the previous section that found higher injury rates in white males actually found lower injury rates for runners who stretched after their workouts.<sup>4</sup> Other research shows that stretching before and after has no effect on muscle soreness.<sup>1,8</sup> Research does not support the effectiveness of anti-inflammatory drugs, antioxidant supplements (vitamins C and E), ultrasound and TENS, stretching, ointments or creams.<sup>7,9</sup> Aspirin taken orally and topically applied as a cream has shown to potentially reduce, but not eliminate, soreness.<sup>9</sup>

The best method for avoiding DOMS is to perform additional bouts of the same exercise that caused it, in addition to a general warm-up for 5 minutes and specific mobility exercise for 15-20 minutes prior to strenuous eccentric muscle activity.<sup>7</sup> Research has shown that even a single bout of the same exercise performed every week can keep the muscles permanently adapted so that DOMS is prevented.<sup>7,9</sup> Starting an exercise program so that the increase in eccentric exercise is gradual will help avoid severe DOMS.<sup>7</sup> Since the muscles respond by rebuilding even stronger, the soreness will diminish with each session and will eventually vanish.

### **How to stretch**

Stretching of sore muscles may further damage them.<sup>5</sup> Research has shown that stretching may cause DOMS by increasing damage. If you feel that a stretch may relieve spasms in sore muscles, stretch very lightly, just enough to feel relief.<sup>5</sup> Stretching to relieve muscle spasms is effective. All stretching should be done when muscles are warm and the body is sufficiently conditioned.<sup>1</sup>

Research has shown that for people under 40, stretching for 30 seconds is more beneficial than stretching for 15 seconds, and stretching for 60 seconds is no more effective than stretching for 30 seconds.<sup>10</sup> For older people, up to age 97, a 60-second stretch was found to be more effective than either a 15 second or a 30 second stretch.<sup>10</sup> This total stretch time can be broken up into short but frequent stretches, which has been found to be just as effective as one longer stretch.<sup>10</sup>

### **Stretching Rules:**

1. In all cases, never stretch with a partner. The partner cannot judge the depth of the stretch you are feeling and by the time you express discomfort, it may be too late and injury may have occurred.<sup>5</sup>
2. If you are an adult and you have never been able to do the splits or touch your toes, you probably never will be able to do these. If you try, you will most likely injure yourself.<sup>5</sup> Short ligaments reduce your flexibility. Stretching ligaments more than 6% beyond their normal length results in tears.<sup>5</sup> Stretching ligaments also destabilizes joints and may cause osteoarthritis.<sup>5</sup>
3. Do not force the stretch beyond the point where you can still tense the stretched muscles.<sup>5</sup> Forced stretching can damage muscles and even the capsule and ligaments of joints.
4. Never do ballistic stretches (bobbing, bouncing). This can result in immediate or residual pain resulting from injury to the soft tissue.<sup>4,5</sup>

### **The Bottom Line:**

1. Skip stretching before exercise.

2. Increase your level of fitness to reduce DOMS and reduce the risk of injury.
3. Warm up for at least 10 minutes including exercises that mimic the upcoming workout or sport.
4. If you want to stretch, save it for your post-workout routine.

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