The Argument Against Static Stretching Before Sport and Physical Activity

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Preexercise static stretching has been used by coaches and athletes for decades in the hope of improving performance and preventing injuries. The scientific literature of the 1980s and 1990s suggested that preexercise static stretching was a good addition to athletes' warm-up before initiation of physical activity.[1,2] This article reviews the current literature and provides information to propose a valid argument against the widely held belief that slow static stretching before sport and physical activity is beneficial.

KEY POINTS

- Static stretching has been used as a warm-up activity for decades, without any credible research to support its benefits for performance or injury prevention.
- Static stretching before activity reduces performance in strength, speed, and power activities.
- Static stretching before activity does not appear to reduce injury.
- Key Words: flexibility, performance, range of motion, warm-up

Performance

Despite early evidence that static stretching before activity did not improve performance,[3] it remains a common element of warm-up routines for physical activity. Contrary to the widely held belief that static stretching improves physical performance, numerous studies have demonstrated that traditional static stretching actually decreases performance in activities that require strength, speed, and power.[3-14] Depth-jump performance, a good indicator of power output, has been shown to be significantly reduced after static stretching,[11,13] as has vertical-jump height.[12,14] Studies of strength and power have demonstrated performance decreases of as much as 30%.[4,5,7-9] Knee-flexion and -extension maximal performance (1-RM) measured 10 min after static stretching were reduced by 7.3% and 8.1%, respectively.[4] Avela et al.[7] and Fowles et al.[9] found reductions in maximal isometric plantar-flexion torque about the ankle joint after the plantar flexors were passively stretched (23.2% and 28%, respectively).

The deficit in performance after static stretching might depend on the type of stretching and mode of activity that follows the stretching routine. The deficit has been shown to last approximately 60 min after completion of the stretching routine[9] and might be a result of changes in reflex sensitivity, muscle/tendon stiffness, or neuromuscular activation.[9,13,15,16] The positive or negative effect on performance after static stretching might depend on the speed of movement required by the activity. In one study, a preactivity static-stretching routine had no effect on either the speed or the accuracy of an explosive tennis serve,[17] so preactivity stretching might not decrease performance of high-speed or accuracy-related movements. Another study demonstrated that significant reductions in isokinetic strength were only evident at low velocities (< 2.62 radian/s).[5] A recent study found, however, that static stretching significantly reduced sprinting performance over a 20-m distance.[10] The results of numerous studies have demonstrated that preactivity static stretching reduces performance in activities requiring strength, speed, and power.[3,4,7-16]

Injury Prevention

In addition to the widespread misconception that preexercise stretching improves performance, a second major reason that many coaches and athletes still view static stretching as an important preactivity ritual is the belief that it reduces the likelihood of subsequent injury. This belief is based on the idea that a "tight" muscle–tendon unit is less extensible without stretching, which means that its tolerance for elongation is lower.[18,19] This intuitive concept has resulted in a widespread belief that stretching will prevent muscle and tendon strain.[18] Nonetheless, the relevant research literature does not support the widely assumed relationship between preactivity static stretching and the risk of injury.[18-29]

A study of lower limb injuries among 1,538 male army recruits found that preexercise static stretching had no effect on injury rates after a 12-week stretching protocol.[20] A 2001 systematic review of experimental and quasi-experimental studies pertaining to the prevention of lower limb running injuries analyzed the collective results of five studies, with 1,944 participants in stretching-intervention groups and 3,159 participants in control groups, and reported that no clear evidence is available to support the notion that preactivity stretching exercises are effective in preventing lower limb injuries.[29]

Some experimental studies have shown a reduction in injury rates when preactivity stretching was included in warm-up activities. A study of high school football third-quarter injury rates demonstrated a reduction in injuries among players who participated in a halftime stretching and warm-up routine compared with those who did not participate in such a routine.[30] A limitation in the applicability of the finding of this study is a lack of distinction between the effect of general warm-up movements from the effect of the static-stretching exercises. A retrospective case-control study of sprinters found that those with hamstring injuries had weaker and less flexible hamstring muscles than those of sprinters who had never experienced hamstring injuries.[31] This finding might be misinterpreted by some coaches and athletic trainers who assume that hamstring weakness and lack of hamstring flexibility caused the injuries. The injury might have been the *cause* of the hamstring weakness and lack of hamstring flexibility, rather than the result.

Although the results of a few studies have suggested a link between preactivity stretching and reduced injury rates,[30,32,33] the majority of the relevant research evidence fails to support the concept.* The etiologies of most sports injuries involve multiple complex factors. Flexibility is one of numerous factors that can affect injury susceptibility. Both fatigue[36] and volume of activity[37] have been suggested as predisposing factors for muscle injury. More research is needed to identify the underlying causes of exercise-induced muscle and tendon injuries, from which we can develop guidelines for training and competition to reduce the likelihood of injury.

Practical Applications and Suggestions

The existing research literature collectively indicates that static stretching within an hour before practice or competition does not improve sports performance, nor does it appear to reduce the risk of injury. Poor muscle strength and limited joint range of motion, however, might reduce performance and increase the risk of injury.[38] Clearly, athletic trainers should prescribe static-stretching routines for some athletes, but stretching before sport practice sessions and competitive events is not advisable. A better time for athletes to perform static stretching is after sports activity[39] or in the evenings. Performing stretching activities at the end of workouts or after practice sessions provides improvements in range of motion similar to those from performing them at other times.[40] Other warm-up activities, including general muscle-warming exercises and dynamic (i.e., active) range-of-motion exercises, might be most beneficial in improving physical performance.[1,41,42] Although adequate research evidence is not yet available to definitively recommend dynamic

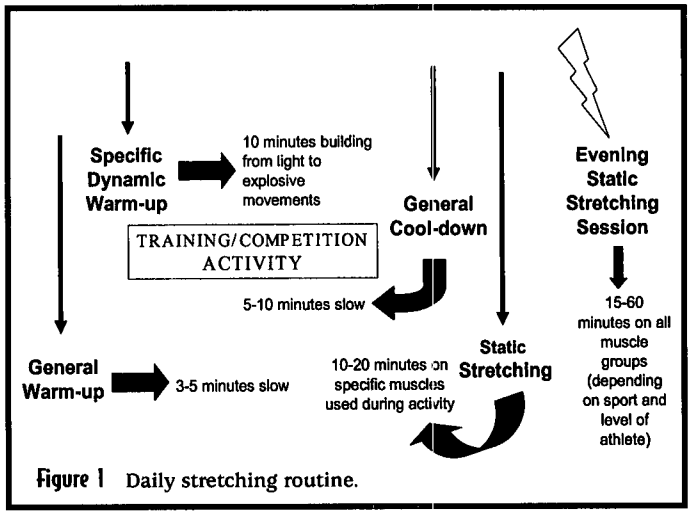

Figure 1 Daily stretching routine.

*18, 19, 22, 24, 25, 27-29, 34, 35.

range-of-motion warm-up exercises, significantly faster 20-m sprint performance after dynamic range-of-motion warm-up has been reported.[8] Athletes might benefit from dynamic warm-up exercises before activity, with traditional static-stretching exercises performed at the conclusion of physical activity. ▮

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