Should Static Stretching Be Used During a Warm-Up for Strength and Power Activities?

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Keywords: warm-up; static stretching; strength and power.

WARM-UP BEFORE PHYSICAL activity is a universally accepted practice with the objective of preparing the athlete physically and mentally for optimum performance and is believed to reduce the risk of injury and enhance performance (15, 28). Warm-ups typically contain 3 components:

• A relatively low-intensity aero-

cobic component that is general in nature such as submaxi-

mum running. The rationale given for this is that it increases core and muscle tempera-

ture, which improves neuromuscular function (15, 22, 28).

• Some stretching of the specific muscles involved in the subse-

quent activity. Some athletes may spend 30 minutes or longer systematically stretching each muscle group. There are many variations of stretching protocols such as proprio-

ceptive neuromuscular facilitation (PNF), static, and dynamic methods. These methods are outlined thor-


**Static Stretching in the Warm-Up**

Although static stretching has been found to be effective in causing an acute increase in the ROM at a joint (1, 11, 17, 30), research indicating that static stretching can also produce a significant acute decrease of, on average, 5-30% in strength (2, 6, 12, 18, 19) and power production (4, 5, 11, 32) of the stretched muscle groups has accumulated. These findings have led some researchers to recommend against the practice of stretching before strength or power activities (4, 16). But it is not clear whether the detrimental effects of stretching used in several studies could have a negative effect on strength and power performance in athletes because the protocols used were not representative of the typical warm-up methods used by athletes to prepare for exercise or competition. For example, stretch treatments of 15-30 seconds duration have been used for a single muscle group (2, 5, 12), which is a greater degree than that commonly used by many athletes for stretch treatments. Furthermore, some studies observed performance decrements after stretching—there was no aerobic component or submaximal exercise preceding the stretching (4, 6, 12, 18, 19) or when there were no practice trials in the tests of the activity (2-4, 6, 18, 19). Although this research design is necessary to isolate the influence of the stretching intervention, it is possible that the detrimental effects of static or low-intensity exercise and practice components of a warm-up may offset any potential negative effects of stretching. For example, a study by Knudson et al. (10) reported a nonsignificant decrease in vertical jump performance after a static stretching routine. Fifty-five percent of the subjects experienced a decrease in performance, whereas other subjects experienced no change or an increase in performance after stretching. In this study, the participants performed 3 minutes of submaximal stretching in a lab practice vertical jumps before the stretching. It is possible that for 45% of the subjects who exhibited no decrease in performance, the cycling and practice jumps had a positive effect.

A recent study has attempted to identify the influence of submaximal running, static stretching, and practice jumps that are components of a warm-up (31). On the basis of a test of concentric vertical jump height, 4 minutes of running was significantly better than a control warm-up, and running plus 4 minutes of subtotal stretching of the quadriceps and gluteals was significantly worse than just running. Furthermore, running plus stretching plus 4 practice jumps was significantly better than the running plus stretching warm-up. These results suggest that stretching produced a negative effect, whereas the run and the practice jumps produced positive effects in the warm-up vertical jumps. Unfortunately, the study did not examine the effect of a run plus practice jumps warm-up, which may be expected to produce the best results. This study supports previous research and indicates that in more realistic athletic warm-up conditions, a little as 2 minutes of static stretching per muscle group can impair power performance.

**Mechanisms of Stretching-Induced Performance Decrements**

Various authors have speculated about the mechanism that explains the decrease in performance of muscular function in a warm-up did not significantly reduce the risk of injury in army recruits undergoing high-intensity training (10, 17, 30). It is clear that static stretching is effective in causing an acute increase in the ROM at a joint (17, 30). It is not clear whether submaximal exercise, e.g., running, cycling, increases ROM (17, 30). But it is thought that the injury prevention benefit of warm-up resides in a short-term reduction in muscle stiffness rather than simply increased joint ROM (7, 8). Reduced stiffness is associated with less resistance force when the muscle is stretched (7, 30) so that there is less likelihood of damage when the muscle is elongated (7). Static stretching has been found to reduce passive muscle-tendon stiffness for up to 1 hour (13, 14), but a reduction has not always been found (30). Furthermore, when muscle-tendon stiffness is measured during muscle contraction (active stiffness), it has been found to be unaffected by stretching (8, 17). In contrast, 10 minutes of running has been found to be effective for reducing the active stiffness of the calf muscles (17). Increased muscle temperature has been shown to increase the resistance to muscle tear (21, 25). Therefore, if active rather than passive stiffness is related to injury risk, this suggests that increasing muscle temperature by submaximal exercise would be more important than stretching for decreasing the risk of muscle-tendon injury. However, there is mounting evidence to the contrary (8, 26). For example, Pope et al. (32) reported in a large study that lameness in a warm-up did not significantly impair strength and power performance, although the duration of the impairment of the exact stretching protocols, and the physiological mechanisms are not yet known. Given the lack of evidence in favor of static stretching during warm-up for injury prevention, it seems justifiable to exclude this component from the warm-up for strength and power activities. Progressive submaximal exercise intended to increase muscle temperature and practice trials of the ensuing activity should be retained.

Some coaches have replaced static stretching with dynamic warm-up activities. For example, Rutledge and Facettion (24) outlined warm-up activities for field hockey that consisted of running drills that isolated various joints and were performed with gradually increasing intensity. When an athletic performance runs through phases of progressively increasing intensity, the joints are taken to a new ROM; therefore, the muscles are being stretched dynamically. Whether such a dynamic warm-up has the same effect as static stretching for increasing ROM or influencing the injury risk is not clear, but is worthy of examination. Further experimentation is needed before the optimum warm-up protocol can be identified.

**References**


**Summary and Practical Applications**

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