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The Role of Flexibility in Injury Prevention and Athletic Performance

Have We Stretched the Truth?

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Abstract

The use of stretching to prevent injury, offset muscle soreness, and improve performance has been widely accepted and promoted in sports. However, little or no scientific evidence supports the practice, and recent research suggests that stretching, which increases flexibility beyond that needed for sport-specific movements, may cause injury. This article presents studies that have looked at the effects of stretching on injury and performance. Many earlier studies that showed benefits of stretching did not look at the effects of stretching alone; they also involved general cardiovascular workouts in the experimental but not control groups. More recent research shows that general fitness, rather than stretching, is a more important risk factor in injury prevention. This article also discusses studies of the relationship between joint laxity and injury and the role that stiffness may play in enhancing performance and preventing injury. Overall, the evidence suggests that increasing range of motion beyond function through stretching is not beneficial and can actually cause injury and decrease performance. These findings should be used to challenge common warm-up practices in athletics.

We deny school-aged children the President's Physical Fitness Award if they can't obtain a specific score on the infamous "sit and reach" test, which is based on their ability to touch their toes. When an athlete hobbles into the athletic training room holding his hamstring, we assume that inflexibility caused his predicament. When a healthy active adult shows up at the orthopedist's office with low back pain, we instantly put him on a regimented hamstring and low back stretching

program. In reality we must ask, Where is the evidence that the lack of flexibility is the root of all injury?

There is mounting evidence that for active individuals, the role of flexibility and injury may not be related. Yet, in the practice of sports medicine, general medicine, athletic training, physical therapy, and more importantly the strength and conditioning component of sport, stretching is still the most common recommendation for curing what ails an active individual. Again, where is the evidence that, in fact, stretching will resolve the majority of sport injury complaints?

Active individuals generally stretch for three reasons: to prevent injury, to offset muscle soreness, and to improve performance. The practice of stretching is based on information passed down from generation to generation that has been accepted and promoted by coaches, physical educators, wellness centers, and sports enthusiasts. There is, however, little or no scientific evidence that supports the practice of stretching. Most studies that have shown a positive effect from stretching have not effectively measured the effects of stretching alone. Instead, they have involved a general cardiovascular activity prior to the stretching for the experimental group and no such activity for the control group. That stretching prevents muscle injury, diminishes muscle soreness, or improves performance because of improved flexibility is simply not supported by evidence from clinical trials. In fact, the most recent research suggests that the very reason why a majority of active individuals stretch—to prevent injury—has no scientific basis, and that, in fact, stretching may cause injury.

Stretching and Injury Prevention

Flexibility comes from a Latin term flexibilis, which simply means “to bend.” Flexibility is defined as the ability of a joint to move through a full range of movement. Assessments of flexibility measure the ability of skeletal muscle and tendon to lengthen. An athlete must have functional flexibility or functional range of motion (ROM), which is defined by the motion required to perform the specific skill. For example, functional flexibility for a hurdler in track would require greater lengthening of the hamstring and a greater range of motion in the sacroiliac joint than that required for a point guard in basketball. Typically in sport, stretching increases flexibility beyond function—that is, beyond what is required for a specific motion.

In everyday life, an individual maintains flexibility in a specific joint by using it. As an individual ages, decreased activity and lack of use of a joint leads to decreased flexibility in that joint. Similarly, in athletics, the activity of the sport itself provides the stimulus needed to maintain the necessary ROM for the specificity of the motion. In sports, it would be more desirable to achieve the required ROM through the specific activity, rather than through stretching, which generally results in ROM exceeding the range needed for performance.

The most noted study questioning the effects of stretching on injury prevention is that of Pope et al.1 They conducted a randomized trial involving 1,538 Army recruits and investigated the effect of muscle stretching on the risk of exercise-related injury. They concluded that a typical stretching protocol did not significantly reduce injury. This study also revealed what actually might be at the heart of the matter, that general fitness may be the most important modifiable risk factor. Pope's study indicated that the greater the cardiovascular fitness, the less likely the individual was to have an injury. Bell et al. also concluded that the greatest contributing factor for injuries in female Army recruits was a comparatively lower level of general physical conditioning.2

The most overstated assumption in sport today is that trained athletes are well-conditioned athletes. A majority of today's athletes cannot meet some of the current fitness recommendations established by the American College of Sports Medicine (ACSM), such as a minimum of a continuous 20 minutes of cardiorespiratory activity, 3 to 5 days a week at 65% of maximum heart rate.3 In the world of sport specificity, the trend is to train specifically for the types of movement for the sport. General fitness is rarely obtained, particularly in team sports such as football, basketball, and baseball, and especially in the cases of larger players, such as offensive linemen in football, whose positions require limited movement. The lack of attention to general fitness has resulted in increasing obesity and decreasing fitness of athletes in many sports.

The fitness level and injury rate among professional baseball players exemplify this trend. The training and conditioning routines for baseball are limited to the performance actions themselves. A high percentage of professional baseball players appear to be overweight or obese as measured by body mass index (BMI). Observation suggests that a majority of players would not be able to perform 20 minutes of continuous cardiorespiratory activity maintaining their heart rate in a target zone of 130 to 160 bpm. The common warm-up for professional baseball players involves a few sprints and then lengthy sessions of stretching, particularly of the hamstring. This might explain the frequent hamstring injuries suffered in baseball. There might not be a group of athletes that stretches more and yet is continually sidelined with significant muscular injury.

Shrier investigated the clinical and basic science research on the notion that stretching before exercise prevents injury.4 He examined the research on immobilization and heat-induced increases in muscle compliance, the effects of stretching in activities that do not require extensive muscle length, the effects of stretching during eccentric activity, damage caused by stretching at the cytoskeleton level, and the analgesic effect of stretching. Shrier concluded that stretching before exercise did not reduce the risk of injury. Analyses of muscle contractile properties during stretching show that stretching just before an activity of high intensity potentially could contribute to a major muscle

injury.5,6

Flexibility has also been a standard goal in many physical therapy and rehabilitation programs. However, it has been noted by McGill that the formal approach to rehabilitation for low back stability should be replaced with an endurance strength component. This would enhance stiffness of the muscular structure, therefore increasing stability.7 Increasing joint stiffness, which is contrary to making a joint more flexible, increases the ability to support applied loads. Increasing stiffness also allows for more efficient energy absorption, which generally would result in improved sports performance.

Laxity, which is a function of the joint capsule and ligaments, has also been looked at with respect to injury and performance. As is the case with flexibility, its contribution can be difficult to discern. Increased hamstring flexibility and joint laxity is associated with a higher incidence of anterior cruciate ligament (ACL) injuries in football players.8 It has been shown that a tighter hamstring is more protective of the ACL rather than a less rigid muscle.9

Research also clearly indicates that women are 5 to 10 times more likely to tear an ACL than are men in comparable sports.10,11 This may be due to joint laxity. It is well documented that women have far more general laxity than men.12-14 In female soccer players, laxity has been shown to be a predictor of injury.15 Studies have also looked at the relationship between an increased incidence of injury and increased laxity in women during pregnancy. This increased laxity appears to be related to the increased and constantly cycling levels of the hormone relaxin. Significant laxity changes have been noted in the sacroiliac joint, the ankle, the knee, and the MCP joint of pregnant women.16, 17 Given that research shows an association between joint laxity and injury and that women have greater joint laxity than men, practices that increase ROM in female athletes should certainly be questioned.

Stretching and Soreness

Anecdotal evidence has led the sports world to believe that stretching reduces muscle soreness. The perceived effect of stretching is more than likely an immediate analgesic effect that has no lasting effects on overall muscle soreness. This effect stems from increased stretch tolerance. As individuals stretch, their stretch tolerance increases—they feel less pain for the same amount of force applied to the muscle.18 The muscle feels less stiff and is perceived as being less sore. There is no evidence, however, that stretching reduces post-exercise pain. A study by Herbert and Michael found that stretching had no effect on delayed onset of muscle soreness or the risk of injury.19

Stretching and Performance

Improved performance is one of the goals of individuals who stretch and those who prescribe stretching. A majority of athletes will state that they feel better when they stretch, which may, in fact, be a result of the

acute analgesic effect of stretching. However, it is only recently that investigators have conducted clinical trials of the effects of increased ROM and its relationship to actual performance, rather than to perception. Gleim and McHugh looked at the relationship of flexibility and performance. They determined that the relationship of flexibility to human performance is sport-dependent.20 Gleim and McHugh concluded that decreased flexibility has in fact been associated with increased economy in running and walking. Stiffness has also been associated with increased isometric and concentric force generation, which would obviously enhance performance in all sports. Nelson and Sidaway established that an acute bout of stretching can have a negative effect on the performance of a single-joint countermovement jump (a jump that moves in a designated direction).21 This again would not be desirable in any sport that was dependent on movement that requires immediate force output. This conclusion is also supported by Gosselin and Burton.22

The practice of stretching has become routine in a majority of fitness programs and in virtually all sports training programs. During the birth of the fitness movement in the 1980s, stretching philosophy changed from using no warm-up prior to stretching to preceding stretching with a cardiovascular warm-up. Now, armed with recent research, we can take the next step and thoroughly question the role of stretching in any sport. Today's athletes, reflecting the general decline in physical activity in this country, tend to be less conditioned for their sports than in the past. Couple this with the specificity of sport training, and we now have a generation of athletes who are conditioned only for the movement of their sport (except, of course, those athletes such as distance runners, swimmers, and cross-country skiers whose sport relies on conditioning for performance). The general conditioning needed to prevent muscle fatigue has been eliminated in a majority of training centers, which has resulted in a number of preventable injuries. The science is clear: Stretching will not prevent such injuries and, in fact, may be contributing to injury. If stretching does not result in decreased injury, or in decreased muscle soreness, or in improved performance, then maybe the time spent stretching should be invested in cardiovascular training for all athletes, regardless of their sport.

Current warm-up practices for reserve athletes in competition also need to be questioned. Professional basketball and football teams, recognizing the value of cardiovascular warm-up as opposed to stretching, are now placing stationary bikes on the sidelines for off-field athletes. Working out on the bike allows the athletes to maintain elevated muscle temperature so that they can return to the game moving at optimal speed. It also reduces the likelihood that an athlete will revert to the practices of sitting and stretching waiting for the call to return to the game. This may not be practical in all sports, but it is possible in many of them.

Science and sports medicine have much to offer athletes that will help enhance their performance. Those of us who work with

athletes—trainers, coaches, physicians, and others—have not, however, used the findings from contemporary research to challenge many of the common practices in athletics. We must begin to use the evidence to develop prescriptions that may differ from current recommendations. The evidence suggests that athletes can adequately train for their sport through conditioning, practicing sport-specific movements, and competing. Increasing range of motion beyond function through stretching is not beneficial and could cause injury and decrease performance. MM

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