The Effects of Stretching on Athletic Performance and Reduction of Injury Rates and Muscle Soreness

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For many years, stretching, more specifically static stretching, has been commonly included as part of regular warm-up routines before athletic events. While static stretching before competition is widely believed to help prevent injuries and improve performance, there is little, if any, scientific evidence that supports this belief. In fact, several research studies have found that static stretching as part of a warm-up routine can actually have detrimental effects on performance, while dynamic stretching has been linked to improvement in performance. This paper investigates research done on static and dynamic stretching and their effects on running performance, injury rates, and muscle soreness.

To better understand this research it is necessary to define the different types of stretching. In general, static stretching is done in a stationary position where a muscle is slowly extended to its full range of motion, and the stretch is held for a length of time. Dynamic stretching involves moving the joints through a full range of motion by performing exercises that mimic specific movements done during exercise (Zimmer, Burandt, & Kent, 2007). Getting more specific, passive static stretching is when stretch torque is slowly applied to a muscle kept in a lengthened position. Active static stretching stretches the antagonist muscle’s outer range when the full inner range of the agonist is actively contracted. Active dynamic stretching uses controlled movements to move each joint through an active range of motion. Static dynamic stretching is similar to active dynamic stretching, but instead of moving forward while performing the movements, the movements are done in place in a stationary position (Fletcher & Jones, 2004).

Several studies have been done on different warm-up techniques and their effects on sprinting performance. One of these studies, performed by Fletcher and Jones (2004) at the University of Luton’s exercise physiology program, studied the effects of four different warm-up protocols on twenty meter sprint performance of ninety-seven male amateur rugby players. Players were randomly assigned to four different warm-up groups: active dynamic stretching (ADS), active static stretching (ASS), passive dynamic stretching (PDS), and passive static stretching (PSS.) Each
warm-up started with a ten minute jog followed by two electronically timed twenty meter sprints with two minutes rest in between. The assigned stretching protocol was performed immediately after the two initial sprints, and was followed by two more twenty meter sprints with two minutes rest in between. The times from the two sprints before and after stretching were averaged and compared. Static stretches were performed on the lower body muscles and were held for twenty seconds per muscle group. Results showed a significant decrease in performance among both static stretch groups, while athletes in the ADS group actually improved performance. A statistically non-significant improvement in performance was also found in the SDS group. Overall, this seems to be a well carried out and credible study. The only downside is the athletes tested were rugby athletes and not trained runners. However, rugby involves a lot of short sprints and the experiment tested sprinting, so it is still can be applied to track and field. The relatively large sample size and use of electronic timing added to the credibility of this study along with the fact that each subject was tested with and without stretching. A downside of this study is that only men were tested, so whether or not females would show the same results is unknown.

Another similar study, performed by Fletcher and Anness (2007), examined the affects of different warm-ups combining static and dynamic stretches on the performance of sprinters over fifty meters. This study has more practical application, because actual track athletes were the subjects of it, and athletes often combine static and dynamic stretching in their warm-ups rather than just doing one type of stretch or the other. In this study, eighteen experienced sprinters were required to complete three randomly assigned stretching interventions followed by a two electronically timed fifty meter sprints. The three stretching groups were: active dynamic stretching (ADS), static passive stretching combined with ADS (SADS), and static dynamic stretching combined with ADS (DADS.) An eight-hundred meter warm-up jog was completed before each stretching intervention. Runners were given four minutes after the stretching was completed to do two practice starts. Two minutes recovery was given between fifty-meter sprints, and a week was given between each stretching
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intervention. The fastest time of the two trials was used for statistical comparison. This study found that SADS, when compared to ADS and DADS, was associated with statistically significant increases in sprint time over fifty meters. While DADS was associated with slightly slower times than ADS, this was statistically insignificant. Overall, this study seems credible and very well carried out. The only downside to it is that is tested a rather small sampling of people all from the same track club. To be more conclusive, a larger sampling from a variety of clubs should be used.

Both of these studies found static stretching to have negative effects on sprinting performance, even when combined with dynamic stretching. They also both found improvement in performance when dynamic stretching was used. These are just two among several other similar studies done that have found similar results.

While much research has been done on the effects of static stretching and sprinting and power events, little research has been done on its effects on distance running and endurance activities. However, there is some research out there of this type such as a study conducted by Wilson et al. (2009) on ten distance and middle-distance runners on Florida State University’s men’s track and field team. The first part of the study consisted of runners completing a thirty minute pre-load run at sixty-five percent of VO2 max on a treadmill with caloric expenditure being recorded while they ran. They were then given a two minute rest period before the next part of the test where they were asked to try to run as far as they could on a treadmill in thirty minutes. Runners were allowed to adjust the speed on the treadmill, but were not allowed to see how far they had run. Each runner completed two sessions of this test—one without any stretching and just sixteen minutes of quiet sitting before the pre-load session, and one including lower body static stretches for sixteen minutes before the pre-load run. The study found that runners expended more energy and covered less distance after stretching. Overall, this was a pretty good study, but there are a few things that could have made it more conclusive. First of all, a small sampling of only young male runners from one team was used. Due to anatomical differences, it is possible that different results may have been
found in females. To be more conclusive, further studies should be done using both genders and people of varying ages from different teams. Also, to be more effective, the maximum distance run should have been performed immediately after the stretching rather than having it after the pre-load run. The activity of the pre-load run may have negated some of the negative effects found to be associated with static stretching prior to exercise.

A similar study performed at the University of Wisconsin, Eau Claire by Zimmer, Burandt, and Kent (2007) on the effects of static and dynamic stretching on running economy found conflicting results with Wilson’s study (2009). The subjects of this study were twelve trained male distance runners between ages eighteen and thirty-six. Participants were assigned to one of three stretching warm-up groups: no stretching, static stretching, and dynamic stretching. Each warm-up started with five minutes of walking on the treadmill at three miles per hour. Both the dynamic and static stretch warm-ups included six lower body exercises which were cycled through two times. The static stretches were held for thirty seconds each with thirty seconds in between each one. The dynamic stretches were performed for fifty meters each time. Prior to the stretching and the running economy test, subjects performed a VO2 max test on a treadmill to determine their ventilatory thresholds. The running economy test was preceded by the assigned stretching protocol and included running on a treadmill at three different predetermined sub-maximal (below ventilatory threshold) levels for seven minutes each. Results from this study found no statistically significant differences in running economy between stretching groups. Similar to the last study, this one was of pretty good quality, but had similar weaknesses. Like Wilson et al.’s study (2007), only a small sampling of young males was used here. The fact that the running economy test was sub-maximal makes this study less applicable to a race situation where a runner would be running at maximal effort. Further research should be done to observe the effects of static stretching on running economy during a maximal effort for a distance run.
Another study performed by Allison, Bailey, and Folland (2008) at the Loughborough University, UK and English Institute of Sport, Sportcity, Manchester, UK found similar results to Zimmer et al.’s study (2007). Ten trained male distance runners, aged between twenty and thirty, completed two treadmill runs of ten minutes at seventy percent of VO2 max each before and after a stretching routine and no stretching. Respiratory gas exchange was measured during these runs. The stretching routine was repeated three times and consisted of eight lower body exercises held for forty seconds each. Runners performed sit-and-reach, isometric strength, and countermovement jump height tests before and after stretching on a separate day from the running tests. This study found that none of the tests related to running economy were affected by the stretching, even though flexibility improved and isometric strength and countermovement jump height performance decreased after stretching. This was also a fairly well performed study, but it has all the same weaknesses as Zimmer et al.’s study (2007).

While static stretching before exercise is unnecessary, because it has been found to have either negative or no effects on running performance, many still believe it should be performed in order to reduce the risk of injuries. A study conducted online by Jamtvedt et al. (2009) studied the relation between static stretching and injuries. The study included 2,377 adults who regularly participate in physical activity. Half of the participants were asked not to stretch before exercise, while the other group was asked to perform seven trunk and lower body static stretches held for thirty seconds each before and after exercising for twelve weeks. Both groups recorded information online in relation to any injuries or soreness experienced. Results from this study found that while stretching did not have statistically significant correlations with overall reduced injury rates, it did correlate with reduced rates of muscle and tendon injuries and bothersome soreness. While the large international sampling is a strength of this study, it is not the most credible study ever due to the fact that it was conducted online in an uncontrolled setting. This study is assuming that all participants followed instructions all the time in regards to stretching or not stretching and recorded all
information accurately. The participants’ activities were not all the same or controlled either. These things may have led to skewed results.

Small, Mc Naughton, and Matthews (2008) at the University of Hull in Hull England did a study reviewing literature regarding the effects of static stretching as part of a warm-up in reducing injuries. They examined 364 randomized and controlled clinical trials relevant to the topic and found seven of them that met the inclusion/exclusion criteria. The studies were evaluated using a methodological assessment and scored with accredited criteria. It was found by all four of the randomized clinical trials that static stretching as part of a warm-up did not have any effect on reducing overall injury rates. One of the three controlled clinical trials found static stretching to help reduce injury rates. Significantly reduced rates of musculotendinous and ligament injuries were found by three of the studies to be linked to static stretching before exercise, however, reductions in overall injury rate were nonsignificant. The study concluded that there is moderate to strong evidence that static stretching before exercise does not help reduce overall injury rates, but there is some preliminary evidence that it may reduce rates of musculotendinous and ligament injuries. More research needs to be done on the relationship between static stretching and musculotendinous and ligament injuries in order to be more conclusive. A negative to this study obviously was that it was not actually an experiment, but it was just a review of other’s research. This seemed like a good review of literature and the fact that multiple studies were examined that found similar results makes this a good source which further strengthens previous arguments. Another negative of this study was that a very small number of studies were found to be of sufficient quality to be included in the review.

A similar literature review was performed by Herbert and Gabriel (2002) where five studies were found to be of good enough quality to be included. These studies found that static stretching before and/or after exercising led to small and statistically insignificant reductions in muscle soreness seventy-two hours after exercising. On a one-hundred millimeter scale the average reduction in
muscle soreness was less than two millimeters. This was concluded for most athletes to be too small of a difference to make it worthwhile to stretch. Two of these studies examined the effects of static stretching before exercise in army recruits and injury rates. When pooled together, these studies found static stretching to be linked to a five percent relative injury risk reduction which is a one percent absolute risk reduction. This difference is statistically non-significant. This study has the same strengths and weaknesses as Small et al.’s study (2008).

Another article by Stone et al. (2006) in the National Strength and Conditioning Association Scientific journal reviewed scientific studies relating to exercise and stretching. Several experiments found that chronic stretching (stretching over time not part of a warm-up) was actually linked to improvements in performance of various types. Improvements were mostly linked to increased forced reduction which resulted in faster running times, longer jumps, etc. This literature review found similar results in regards to effects of static stretching before exercise on athletic performance in power events and effects of stretching on injury prevention. This study has similar strengths and weaknesses as the previous two discussed since it was another literature review.

Overall, it seems as though most of the research agrees that static stretching prior to exercise leads to decreases in power output. This makes sense when the science behind it is considered. Static stretching lengthens and decreases the stiffness of the musculotendinous unit which stores elastic energy and releases elastic energy with each contraction. Stiffer muscles allow more elastic energy to be stored and released with each contraction. More elastic energy equals greater force production which results in running faster or jumping farther or higher. Knowing this, it only makes sense that stretching the muscles out would lead to slower sprint times and overall decreased performance in power events. Most of the research also agreed that dynamic warm-ups lead to improved performance in sprinting events. This is believed to be due to the face that the movements closely mimic those performed during a sprint and provide rehearsal for the muscles and may
improve coordination. This also increases core temperature and blood flow to the muscles directly involved in sprinting (Zimmer et al., 2007).

While it is clear that static stretching has negative effects on sprinting and power events, it is a little less clear what its effects are on distance running and endurance events. The different findings among the articles discussed here can be explained. The two studies that found static stretching to have no impact on running economy both had runners run a sub-maximal pace. The sub-maximal pace would result in the use of more type one fiber slow twitch muscles and less recruitment of the type two fast twitch muscles used when sprinting. The slow twitch muscle use may have allowed more time for the muscles to adapt to the changes in the musculotendinous unit from stretching, and the type one fibers’ aerobic capability may have over-rid the negative effects of stretching on the muscles. Had these tests been performed at a higher intensity, more type two fibers, which rely on stored elastic energy, would have been recruited and negative effects of static stretching may have been observed (Zimmer et al., 2007). The study that found decreased performance in distance running was assumingly performed at a maximal pace as runners were asked to run as far as possible during a thirty minute time period. This higher intensity may have relied on the use of more type two muscle fibers and stored elastic energy which could explain why this study found opposite results from the other two.

As far as stretching to reduce injuries goes, most studies are in agreement that static stretching before or after running does not reduce overall injury rates, but may reduce musculotendinous and ligament injury rates. Further research is needed in order to be more conclusive as to whether or not static stretching can help reduce injuries to muscles and ligaments. The possible reduction in injuries to muscles and ligaments due to stretching could be linked to the increased range of motion that comes with stretching. It often seems like common runner injuries are caused by a tight muscle pulling on another muscle or ligament causing it to hurt. Stretching could possibly help reduce injuries of this nature. Sports that require more flexibility will benefit from
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stretching and likely see decreased injury rates due to overextension of muscles. However, most track and field events do not require a large range of flexibility other than hurdles. A reason why, unlike common belief, stretching does not reduce overall injury rates, is because most common injuries such as pulling a muscle do not occur as a result of extending a muscle beyond its normal range of motion (due to inflexibility), but actually occur during eccentric loading (Stone et al., 2006).

It is unknown why chronic static stretching has led to increased performance in power production activities. It could possibly be due to increased flexibility which allows increased range of motion. In terms of running, the farther the leg can be brought up into the air, the more power that can be produced coming down which results in a greater force pushing forward due to Newton’s third law of physics that states every action has an equal and opposite reaction (Benson, 2009).

Despite common beliefs that stretching reduces muscle soreness, research seems to agree that this is false and stretching leads to very small and statistically insignificant reductions in muscle soreness. The reason why stretching does not reduce muscle soreness, as commonly believed, is likely, because soreness is the result of muscle hypertrophy and the muscles recovering from the tiny tears that occur during exercise. Stretching also causes tiny tears in the muscle, so adding more tiny tears to already recovering muscle is not going to help it. A possible reason for the small, but insignificant reduction in the onset of muscle soreness after stretching could be, because muscles often get really tight after heavy use and stretching may loosen up the tight muscles a little bit (Quinn, 2008).

Overall, this research seems to conclude that dynamic stretching as part of a warm-up has been shown to have positive effects on running performance, while static stretching as part of a warm-up has been found to have negative effects on sprinting performance and possibly on distance running as well. Static stretching before exercise has not been proven to reduce overall injury rates or muscle soreness, although some studies have found it to correlate with reductions in musculotendinous and ligament injuries. Increases in power production capabilities have been linked
to chronic stretching outside of a warm-up routine. Based on these findings, I would recommend that all my athletes, regardless of event group, perform only dynamic stretches before exercising. Even though performing dynamic stretches along with static stretches has been shown to negate some of the negative effects of static stretching, using just dynamic warm-ups has been shown to produce better results, and few, if any, benefits have been linked to using static stretches before exercise. Due to the increases in power production capabilities found to be linked to chronic stretching outside of warm-ups, I would recommend that my athletes perform static stretches after their workouts or separate from them altogether, such as when they get out of the shower and still have warm muscles. The finding that static stretching has negative effects on sprinting seems to go along with my personal experience. Although I was warming up with a combination of static and dynamic stretches, I plan to change my warm-up routine to only include dynamic stretches, and save the static stretches for after exercising.
References


