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The Effect of Pre-Event Static Stretching on Sprint Speed

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PRF 810
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December 2007

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Introduction

On any given day at a park, gym or other recreational venue, you can witness the pre-exercise ritual known as static stretching. It has been prescribed for years to elite and recreational athletes as a form of injury prevention and performance enhancer due to the benefits of flexibility and range of motion (15). With the advent of recent performance enhancement studies this theory is being reviewed and training methodologies are being restructured to account for recent findings. However, this information is still on the research and academic level and there haven't been concrete findings to bring about an industry consensus to initiate a system wide change in pre-event warm-up protocols. This gap in theory and application has left many uninformed athletes unable to compete at their highest level due to the decrease in force production during events that require explosive power or speed.

It is widely known in academic circles that stretching decreases muscle and tendon stiffness (7, 8, 9, 11), which is necessary for concentric force production during explosive movements; furthermore, research has shown that pre-event stretching decreases power (1, 2, 3, 4, 7, 9, 12, 13) and muscular strength and endurance (5, 8).

This paper will discuss the outcome and practical implication of research that focused on the relationship of stretching and its effect on the production of force. Additionally, alternative methods to pre-event warm-ups will be offered in an attempt to facilitate the change in pre-event warm-up protocols and increase overall force production in athletes.

Research Question: Does pre-event static stretching effect sprint speed?

Annotated Bibliography

1. Nelson, A.G.; Driscoll, N.M.; Landin, D.K.; Young, M.A.; Schexnayder, I.C. Acute effects of passive muscle stretching on sprint performance. Journal of Sports Sciences. 2005; 23(5):449-454.

The purpose of this study was to ascertain the effects on sprint speed of an athlete after a bout of static stretching. Participants in the study performed one of four stretches once per week and 4 times in each session while holding the stretch for 30 seconds. Following the pre-event stretch session the participants were then timed in three 20 meter sprints. After further analysis the researchers there was a significant difference in the time for the no-stretch protocol, it was significantly faster. This research offers come practical implications of the stretching protocols utilized by athletes in sprint events. It was also noted by the researchers that the stretch protocols did not focus on the quadriceps and only on the hamstrings, they believe that if the quads were stretched there would have been more of a detriment to power production. The research conducted by Nelson, et al, (1) shows that pre-event stretching can cause a decrease in power output and ultimately sprint performance.

2. Little, T.; Williams, A.G. Effects of differential stretching protocols during warm-ups on high-speed motor capacities in professional soccer players. Journal of Strength and Conditioning Research. 2006; 20(11):203-207.

The goal of this study was to show the detrimental effects of static stretching on sprint performance while offering an alternative form of stretching, namely dynamic stretching, to help improve sprint performance in soccer players. Participants underwent a series of 3 different warm-up protocols consisting of a static stretch, no stretch or a dynamic stretching routine. Post warm-up testing consisted of a vertical jump, stationary 10 meter sprint, flying 20 meter sprint and a zig zag course. Of the four test, the no stretch and static stretch protocols received the same scores on all test except the 20 meters (which was faster with the static stretch group), while dynamic stretch had higher scores than no stretch in everything but the vertical jump (which showed no significant difference in any of the protocols), however when comparing dynamic stretching to static stretching all scores were identical except for the zig zag test (which was higher with the dynamic stretching protocol). These findings only partially support the researcher's hypothesis, because static stretching did not necessarily deteriorate performance but dynamic stretching did prove to be the preferred choice over the no stretch protocol. Overall the research conducted by this group did support the claims that dynamic stretching is more beneficial to an athletes overall power production.

3. Marek, S.M.; Cramer, J.T.; Fincher, A.L.; Massey, L.L.; Dangelmaier, S.M.; Purkayastha, S.; Fitz, K.A.; Culbertson, J.Y. Acute effects static proprioceptive neuromuscular facilitation stretching on muscle strength and power output. Journal of Athletic Training. 2005; 40(2):94-103.

The researchers in this study looked at the differences between static stretching and proprioceptive neuromuscular facilitation on six variables of performance, including maximal power and peak torque. The results of this experiment showed decrease in performance, including maximal power and peak torque, as a result of both static and PNF stretching. The authors also mentioned that contrary to previous studies velocity did not play a part in performance deficits of peak torque, which they suggest would then lead to detrimental effects in both power and strength performance. The researchers in this article have concluded that both static and PNF stretching will decrease performance of athletes that need to produce power quickly, suggesting that stretching should be used sparingly and in context to the sports requirements.

4. Egan, A.D.; Cramer, J.T.; Massey, L.L.; Marek, S.M. Acute effects of static stretching on peak torque and mean power output in national collegiate athletic association division I women's basketball players. Journal of Strength and Conditioning Research. 2006; 20(4):778-782.

The researchers in this study were interested in the peak torque and power output of athletes after a bout of static stretching. Utilizing preset static stretching protocols athletes performed static stretching then they were tested on their strength with a cycle ergometer. The resulting tests showed that there were no decreases in peak torque and mean power output. An interesting finding by the researchers was that previous studies on this topic have been conducted on untrained recreational participants, while this study was conducted on trained collegiate athletes. The researchers believe that this finding is due in part to chronic training and subsequent adaptation of the neuromuscular system by trained athletes during sport specific training. This theory adds a new dimension to the topic of static stretching and power production with the addition of prior training of the participants and their neuromuscular competence.

5. Nelson, A.G.; Kokkonen, J.; Arnall, D.A. Acute muscle stretching inhibits muscle strength endurance performance. Journal of Strength and Conditioning Research. 2005; 19(2):338-343.

The author of this study conducted two simultaneous studies to insure reliability of the findings. The difference in the groups was when their stretch treatment was applied, however both groups had the same outcome which proved the reliability of the experiment. It was found that stretching prior to a muscular strength test would decrease the amount of reps that the subject is capable of doing. This information is important because it has been speculated for years that muscular strength and muscular endurance respond similarly to the effects of static stretching on performance. These findings open the possibility of including a wider range of sports and activities that might be affected by the detrimental characteristics of static stretching. Specific outcomes for this paper would be that the performance of a sprinter would not just be affected on their initial explosive start, but also on their following steps and need for muscular endurance closer to the end of the event, as in an event like the 100 meters where maximal force is applied on each step.

6. Nelson, A.G.; Kokkonen, J.; Eldredge, C.; Cornwell, A.; Glickman-Weiss, E. Chronic stretching and running economy. Scandinavian Journal of Medicine and Science in Sports. 2001:260-265.

This research study looked at the effects of stretching on running economy. Running economy, amongst other variables, includes the ability of the stretch shortening cycle to move the joints through the phases of gait by using as little energy as possible. The results of the study concluded that after the ten weeks of static stretching that although there was an increase in range of motion and flexibility there was no significant change in running economy, or for the purpose of this paper there was no change in the stretch shortening cycle's ability to maintain running economy. These results help to focus the impact of the effect of static stretching to sprint events only and helps exclude endurance level running events.

7. Fowles, J.R.; Sale, D.G.; MacDougall, J.D. Reduced strength after passive stretch of the human plantarflexors. Journal of Applied Physiology. 2000; 89:1179-1188.

The researchers in this study took a more defined approach to the topic of performance changes due to stretching, by looking at a specific group of muscles, the plantarflexors. Prior to testing of the subject's plantarflexor isometric strength, participants went through an extensive stretching protocol. The results were that there was a decrease in maximal voluntary force (isometric strength) due to stretching. Additionally, it was also reported that this effect would continue for up to one hour. This is a key variable to be considered when prescribing stretching protocols to athletes prior to participating in an event. Isometric muscle stiffness is critical to speed due to its ability to stabilize the muscles needed for force production.

8. Weir, D.E.; Tingley, J.; Elder, G.C.B.; Acute passive stretching alters the mechanical properties of human plantar flexors and the optimal angle for maximal voluntary contraction. European Journal of Applied Physiology. 2005; 93:614-623.

This study was a follow up to Fowles et al. (7), because they believed that the results did not properly distinguish between the two possible causes for the decrease in isometric muscle voluntary contraction, which are changes in mechanical properties and reduced muscle activation. In this study, after the bout of static stretching occurred there was a post test that measured the isometric strength of the plantarflexors. The results were not consistent with Fowles et al. (7), as it was concluded that the decrease in isometric strength of the plantarflexors was in fact due to changes in mechanical properties and not reduced muscle activation. Mechanical properties would comprise of the muscle length, meaning that the length tension relationship has been compromised, which does not allow for the muscles to retract as need to produce the required amount of force.

9. McMillian, D.J.; Moore, J.H.; Hatler, B.S.; Taylor, D.C. Dynamic vs. static stretching warm up: the effect on power and agility performance. Journal of Strength and Conditioning Research. 2006; 20(3):492-499.

The researchers in this study were interested in difference between dynamic and static stretching protocols on athletic performance. Utilizing a battery of posts stretching test, the researchers found that dynamic stretching protocols offered an increase in performance as compared to static stretching or no stretching. However it should be noted that there were no differences between the stretching and the non stretching control group, which means that static stretching in this experiment did not diminish performance. The researchers theorize the reasoning behind the performance enhancement effects of dynamic stretching could be because of the temperature increase that occurs during an active warm up and the post activation potentiation (PAP), which is an increase in muscle twitch force and rate of force development following a conditioning contractile activity, as stated by McMillian et al (9). This study is useful in suggesting an alternative to static stretching that will offer some performance enhancement effects.

10. Unick, J.; Kieffer, S.; Cheesman, W.; Feeney, A. The acute effects of static and ballistic stretching on vertical jump performance in trained women. Journal of Strength and Conditioning Research. 2005; 19(1):206-212.

This study looked at the difference between static and ballistic stretching protocols on vertical jump performance of trained women. The results of this study were that there were no significant differences between vertical jump performances regarding the use of the static or ballistic stretching protocols. What is interesting about this study was the researcher's decision to utilize a ballistic stretching protocol in this experiment as opposed to a dynamic or PNF stretching protocol, because the dynamic or PNF stretching protocols are more widely used and more often compared to static stretching. Additionally, ballistic stretching has been in much debate regarding its possible contraindications to injury prevention. However, this study is important to this paper because vertical jump performance is a power event and the results can be directly transferable to sprint speed, which is also a power event.

11. Bradley, P.S.; Olsen, P.D.; Portas, M.D. The effect of static, ballistic and proprioceptive neuromuscular facilitation stretching on vertical jump performance. The Journal of Strength and Conditioning Research. 2007; 21(1):223-226.

In this study researchers were interested in the difference between static, PNF and ballistic stretching on vertical jump performance. The results varied, showing a decrease in jump performance in all stretching protocols, with ballistic stretching having the smallest decrease of the three and static and PNF having the same percentage of decrease although still higher than ballistic stretching. However, researchers noted that after 15 minutes jump performance was back to normal. This study helps with stretch protocols for athletes as it is recommended no to participate in explosive activities the first 15 minutes after a bout of stretching.

12. Shrier, I. Kokkonen, J.; Nelson, A.G.; Eldridge, C.; Winchester, J.B. Chronic static stretching improves exercise performance. The American College of Sports Medicine. 2007; 39(10):1825-1831.

This article discusses the role of chronic (long term) static stretching as a performance enhancer. The researchers in this study looked at only non trained or recreationally trained subjects that did not participate in exercise activities during the ten week study period. To confirm reliability a VO2max test was conducted before and after to confirm that there was no activity done to increase fitness level other than the stretching protocol for the stretch group and the lack of stretching for the control group. After the ten weeks, subjects went through post test of flexibility, power, strength and endurance. The results concluded that there were performance enhancements in all four variables. Although this study focused on untrained or recreationally trained subjects, the results still supports the findings of previous articles that state that chronic stretching is more beneficial than acute stretching. Additionally, the authors suggest that chronic static stretching programs be implemented by untrained individuals as an introduction to an exercise program.

13. Shrier, I. Does stretching improve performance?: A systematic and critical review of the Literature. Clinical Journal of Sports Medicine. 2004; 14(5):267-273.

In this comprehensive literature review the author was interested in finding evidence that stretching improved performance. This study reviewed articles concerning force production, velocity of contraction, running economy, running speed and over all consensus of stretching efficiency (is it detrimental or beneficial). Due to the contradictory results the author separated the results by acute bouts and regular long-term stretching. In regards to acute bouts of stretching there were decreases in performance of force production and velocity of contraction while running economy showed improvement and running speed was inconclusive. Regarding regular long term stretching improves force production and velocity of contraction, but there was no effect on running economy and running speed was inconclusive. The author suggests that the improvement in performance as a result of long term stretching is due to stretch induced hypertrophy, which in turn will increase force production and the velocity of muscular contraction. This information helps to paint a more complete picture of the aspects and indications for stretching protocols for athletes.

14. Weerapong, P.; Hume, P.A.; Gregory, S.K. Stretching: Mechanisms and benefits for sport performance and injury prevention. Physical Therapy Review. 2004; 9:189-206.

In this literature review the authors give a methodological assessment of the four major types of stretching, which are; static, PNF, ballistic and dynamic. This review offered some very insightful indications and contraindications for each possible stretching protocol and future implications for the use of each one in a clinical and practical setting. The overall analysis concluded that the evidence was inconclusive to suggest the use of one form of stretching over another. Additionally, the authors state that each sport requires different levels of eccentric, concentric and isometric contraction which may predispose a certain type of stretching protocol over another. The authors also suggest that further research may need to be conducted on the effectiveness of dynamic stretching because it does not follow the systematic hold time of the other three stretches which makes it hard to make a an accurate comparison.

Clinical Implications

The research offers conflicting results of the effects of training on muscle contraction velocity, peak torque and ultimately power production all of which lead to sprint speed. However the benefits of stretching outweigh the risks and in scenarios that compare the results of stretching to non-stretching participants, the results are often equal or slightly more favorable to the stretching participants. This would suggest that since there are no deficits from static stretching then its implementation in a real world setting would be appropriate for use by elite and recreational athletes.

Unfortunately, the purpose of a pre-event ritual should be to increase performance, if the ritual does not perform this task then that time could be used for something more productive. An appropriate alternative to static stretching would be dynamic stretching. Dynamic stretching offers the athlete the opportunity to warm-up and activate the muscles needed for power production while maintaining the stiffness needed to regulate an adequate length tension relationship. Exercises include, but do not limit, lunges, high knees, butt kicks, prone scorpions and arm swings just to name a few. In research that has compared different stretching protocols, results have shown that dynamic stretching offers more performance enhancement benefits than static stretching. This alternative to static stretching allows athletes to be more productive during their pre-event rituals as well as increase performance in events that require explosive power, like sprint speed.

Conclusion

The industry of exercise physiology is saturated with studies on stretching protocols and each one seems to have a different stance on the topic. How can we apply what we know to the general public? How can an exercise physiologist support his program design if each article contradicts the previous one? Well there is one thing that is almost guaranteed and that is that consistent training will lead to consistent results.

Egan et al (4) studied the effects of static stretching on collegiate basketball players, in which he found no deficits in power output following a static stretching routine. This group speculated that the reason for their results was that the neuromuscular make-up of the athletes, following chronic sport specific training, was well tuned and easily adjusted to the stretching of the muscles and recoiled rather quickly in preparation for explosive power. This is not an isolated event as was shown in research by Little et al (2) who studied the effect of static stretching on professional soccer players. This study supported claims made by Egan et al (4), whereas there were no significant changes in performance after a bout of static stretching.

Just as controversial are the performance benefits of dynamic stretching, however studies have shown a direct correlation between pre-event dynamic stretching and performance enhancement. Activating and priming the stretch reflex of the muscles through dynamic stretching has shown significant increases in performance versus no-stretch and static stretching protocols. Dynamic stretching should be the preferred choice for athletes looking for an edge in competition during their pre-event routine.

However, those athletes who are not familiar with dynamic stretching protocols should be advised to maintain their static stretching routines to aid in flexibility, muscle warm up and injury prevention.

To conclude, although the data is often contradictory regarding performance enhancement benefits of different stretching protocols, a thorough investigation on the available literature will yield a consistent pattern. This paper has attempted to connect the dots with articles that were relevant to the theory and practical implementation of pre-event stretching protocols and performance enhancement as it relates to sprint speed. It is overwhelmingly evident that static stretching and dynamic stretching are both more conducive to athletic performance than not stretching at all. Although one may yield higher returns in regards to performance, it is primarily the athletes' choice as to which stretching protocol they desire to use, as neither will diminish athletic performance. Lastly, it should be the goal of the exercise physiologist in the position of athletic trainer, strength and conditioning coach or sport specific coach to design a program that best suits the needs of the athlete to prepare them for the requirements of their sports and ultimately to enhance their performance.

Future Research

Current research on the effects of static stretching on performance has been very comprehensive in regards to its laboratory observations; however the athlete competes on the track, the field and the court. Future research would benefit from comparing results of stretching protocols in the athletes' natural environment, i.e. a soccer match, a basketball game or a track meet. This would allow the athlete to move naturally in their environment, while the researcher uses video cameras to later analyze their movements, measure their jumps and time their maximal speed throughout the course of an event. I realize this may be more time consuming but the information would be more consistent with the actual needs of the athletes and their respective sports.