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The Effects of Various Stretching Protocols on Rate of Force Development in Collegiate Athletes

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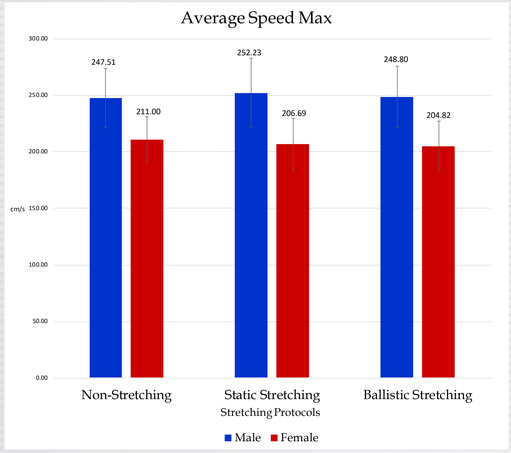
Abstract

PURPOSE: Stretching is part of a dynamic warm-up that is commonly used in preparation for a number of different sporting events. Previous research suggests that stretching may decrease musculotendinous stiffness, which has a possibility to cause an increase in slack of the tendon, therefore, decreasing the speed of force from muscle to bone. The aim of this study was to assess three independent stretching protocols and their individual effects on the rate of force development.
METHODS: Ten male and nine female subjects (20 ± 3 years) from the Bethel University basketball teams participated in this study. Subjects were randomly assigned to perform three different stretching protocols on separate days: non-stretching (NS), static stretching (SS), and ballistic stretching (BS). For each stretching protocol, subjects performed a pre- and post- sit and reach test. Once the stretching protocol was complete, a four minute rest period took place. After this, five jump measurements were measured consisting of the countermovement jump (CMJ) for speed (cm/s) and power (W/kg) output measurements, standing vertical jump (cm), three-step vertical jump (cm), and broad jump (cm). A triaxial accelerometer (Myotest, Switzerland) was used to determine rate of force development (RFD), which then was compared to the vertical and broad jump measurements to determine if the stretching may have caused tendon elongation that would affect their RFD and, therefore, disrupted neuromuscular communication. Each subject completed their testing within three weeks from the initial visit.
RESULTS: One-Way ANOVA analysis using SPSS software demonstrated no significance ($p \leq 0.05$) in all five categories between the three stretching protocols.
CONCLUSION: The data indicated that the different stretching protocols did not have a significant effect on the rate of force development in the athletes. Based on the replicated protocol from Unick et al. (2005), we were able to conclude that any time an athlete has a rest period of four minutes after their stretching, it has the potential to negate the neuromuscular responses to stretching altogether, taking away any affects it may have on the athlete's performance. Therefore, stretching is unnecessary to add into an athlete's dynamic warm-up.

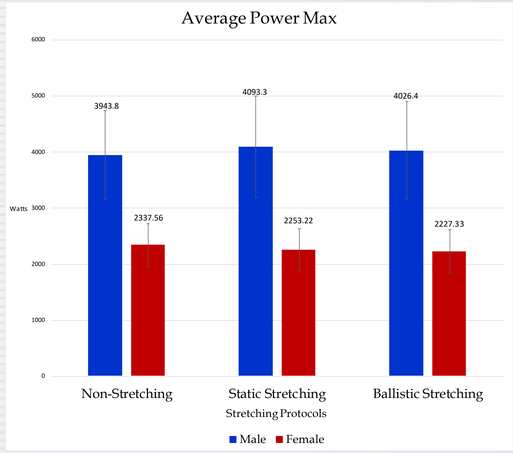
Introduction

Looking at athletics throughout history, stretching has been integrated into many fitness activities and exercise routines based on it's preconceived health benefits. These benefits included reducing the risk of injury, decreasing muscle stiffness of the muscle-tendon unit leading to an increase range of motion, lightening pain, and improving athletic performance. However, many of those health benefit theories are being challenged by recent research on the acute effects of stretching. This recent research has been focused around the idea of whether stretching should be incorporated into a dynamic warm-up prior to competition, and identifying if it is advantageous or detrimental to one's athletic performance. Some researchers argue that stretching may decrease musculotendinous stiffness, which could possibly cause an increase in slack of the tendon, therefore decreasing the speed of force from muscle to bone. It's also been suggested that decreases in the athlete's strength can be attributed to an increase in the length of the muscle tendon unit.

After examining past research on whether it is beneficial to stretch before competitive events, it was determined that the current research should address the acute effects of static and ballistic stretching on rate of force development (power) within an athlete. The rate of force development will assess stiffness in the tendon because any slack in the tendon as a result of stretching will decrease the rate of force. This also might suggest impaired rate coding or a decreased neuromuscular transmission. However, it might instead suggest the opposite, which would be a heightened rate coding or an improved neuromuscular transmission since they work together. Rate coding is essentially the speed at which we are activating more motor units. Along with rate of force development, the jump scores of each subject will be measured through both vertical and broad jumps. It's important to compare the rate of force development data to the jump scores for all three stretching regimens in order to determine which method most benefitted the athlete's performance.



Graph 1



Graph 2

Treatment	Standing Vertical (cm)	Three-Step Vertical (cm)	Broad Jump (cm)	Speed Max (cm/s)	Power Max (W)
Non-Stretching	58.49 ± 8.26	63.77 ± 11.94	222.84 ± 33.39	230.22 ± 29.78	3182.95 ± 1020.53
Static Stretching	58.55 ± 8.24	64.97 ± 11.16	224.74 ± 32.10	230.66 ± 35.42	3221.68 ± 1159.55
Ballistic Stretching	58.75 ± 8.55	64.77 ± 10.60	226.25 ± 34.52	227.97 ± 33.23	3174.21 ± 1129.40

Table 1

Methods

Ten male and nine female subjects (20 ± 3 years old) from the Bethel University basketball teams participated in this study. All subjects were concurrently participating in a preseason workout program that included a sport-specific weight training program, agility drills, and open gym pick-up games. This population was chosen because each subject had previous jumping experience as part of his/her prior and current training and sport-specific participation. After recruitment, each participant was asked to sign up for three separate appointments of about 60 minutes. The three appointments were completed at the same time on three separate days within a three week time frame. The subjects were then asked to participate in a baseline sit and reach test in order that the investigators could determine muscle/tendon stiffness in the legs prior to participation in the research protocol. Following the sit and reach test, each subject was conducted through a warm-up session on the treadmill and then subjects rested for thirty seconds.

All of the subjects were randomly assigned to one of the three stretching protocols: non-stretching, static stretching, or ballistic stretching. For the static and ballistic stretching protocols, participants performed four different lower body stretching exercises (the seated bilateral hamstring stretch (Figure 1), the standing unilateral calf stretch both with and without a bent knee, and the standing unilateral quadriceps stretch) designed to stretch the major muscles involved in executing a vertical jump. Each stretch was completed 3 times and each repetition was held for 15 seconds. However, no stretches were performed for the non-stretching protocol. Following the stretching protocol, all three testing sessions required the subjects to go through a four minute walking period. Afterwards, the jump tests that were conducted included the countermovement jump with a triaxial accelerometer, standing vertical jump (Figure 2) and three-step approach vertical jump using the vertec, and the broad jump. Once the performance measurements were completed, each test subject was taken through a final series of three sit and reach tests in order to determine if the tendon stiffness changed drastically as a result of the study.

Results

A one-way ANOVA analysis was conducted using SPSS software to find statistical difference ($p \leq 0.05$) between one of the three stretching protocols. The mean measurements along with standard error are given (Table 1) for the five performance tests. The One-Way ANOVA test revealed no significant difference between the three stretching protocols in standing vertical ($p = 0.995$), three-step vertical ($p = 0.943$), broad jump ($p = 0.954$), speed max ($p = 0.966$), or power max ($p = 0.991$).

Conclusion

The data indicated that the different stretching protocols did not have a significant effect on the rate of force development in the athletes. Based on the replicated protocol from Unick et al. (2005), we were able to conclude that any time an athlete has a rest period of four minutes after their stretching, it has the potential to negate the neuromuscular responses to stretching altogether, taking away any affects it may have on the athlete's performance. Therefore, stretching is unnecessary to add into an athlete's dynamic warm-up.

In order to determine if long-term effects of stretching would influence rate of force development, a longitudinal stretching program would be conducted over a 3-12 week period. Additionally, incorporating other stretching techniques and power-producing athletes may influence different results.

Figure 1

Figure 2

Acknowledgments

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