

## Original Research

# The Acute Effects of a Dynamic Stretching Protocol on Wingate Performance

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### ABSTRACT

*International Journal of Exercise Science 7(4): 271-277, 2014.* Stretching before performing anaerobic activity has been a highly debated subject, with studies finding differing results depending on the type (static, dynamic, etc.) and duration of the stretch. Furthermore, the effects of dynamic stretching (DS) on anaerobic performance have been minimally researched. The purpose of this study was to examine the effects a DS protocol had on power performance using a Wingate test (WAnT). College-aged male subjects were recruited for this study. Prior to experimental trials, subjects performed a familiarity WAnT trial. Subjects then performed the WAnT two more times, once with DS and once without stretching (NS), in a balanced cross-over design. Relative peak power (RPP), relative mean power (RMP), fatigue index (FI), and rate of perceived exertion (RPE) means were compared across DS and NS trials using one-way repeated measure ANOVA's,  $\alpha = 0.05$ . No significant differences ( $p > 0.05$ ) were found across DS and NS protocols among RPP, FI, and RPE. However, there was a significant difference ( $p = .043$ ) in mean RMP between the DS protocol and NS treatment. These findings suggest that some forms of dynamic stretching may significantly decrease mean power during anaerobic performance. More research is needed to explore the different combinations and duration of dynamic stretching needed to illicit a positive response.

KEY WORDS: Maximal exercise, power output, anaerobic power

## INTRODUCTION

Anaerobic performance usually includes short duration, high intensity exercise primarily using the phosphagen and fast glycolytic energy systems. During anaerobic glycolysis, when ATP is needed at very fast rates, glycolytic molecules are broken down rapidly. Ultimately this process will lead to decreased performance and muscle fatigue because of the by-products of anaerobic glycolysis. Often this

muscle fatigue is due to a decreased anaerobic capacity.

Stretching before performing anaerobic activity has been a highly debated subject, with studies finding differing results depending on the type (static, dynamic, etc.) and duration of the stretch. Franco et al. (4) found that static stretching prior to a Wingate Anaerobic Test (WAnT) resulted in a decrease in absolute peak power (APP) and absolute mean power (AMP). Samson

et al. (7) further concluded that although static stretching decreases power output, it increases range of motion. Many studies show that dynamic stretching (DS) can improve anaerobic power (8).

Dynamic Stretching, often sport or exercise specific, is a repeated combination of lengthening and shortening muscle contractions over a period of time. This series of intermittent hops, bounds, and skips help improve joint mobility and range of motion, while decreasing chance of injury. Dynamic Stretching is proposed to enhance muscle activation, resulting in a higher power output. Turki et al. (8) showed how one to two reps of DS for 20 meters within a five minute warm up could improve sprint performance in highly trained males. Yamaguchi et al. (9) supported this finding concluding that DS increases power in the stretched muscle. However, too long of a dynamic warm-up can cause fatigue in an athlete before they perform, thus negatively impacting performance (4).

Dynamic Stretching is regularly used in warm ups because it optimally prepares an individual for high intensity activity (6). Research by Han et al. (5) supported this theory by documenting a greater decrease in sprint time in sprinters after they performed a DS regimen as opposed to static stretching or no stretching protocol. Given that many of the previous studies were performed using well-trained athletes, more studies using the general population are warranted. This would allow for broader generalizations to be made about the effects of DS on performance.

Anaerobic performance can be measured using power or strength based tests such as the cycling WAnT. This test is used to measure anaerobic capacity and peak anaerobic power. The test involves the subject cycling at max effort for thirty seconds against a predetermined resistance load based on the individual's body weight (kg). The measures produced from a WAnT are relative peak power (RPP), relative mean power (RMP), and fatigue index (FI). The WAnT is used in a variety of sports measuring high intensity, power output.

The effects of DS on anaerobic performance have been minimally researched. Finding ways that stretching improves performance while reducing injury is important to athletes and the general population. DS has been shown to increase power, and thus performance. Therefore, more research should be conducted to further examine the benefits of DS including, the best types and optimal duration in order to maximize performance.

In our study, power performance was assessed using a leg-cycling WAnT. Other than Franco et al. (4), there are not many WAnT studies involving stretching protocols and their effect on power. Franco et al. (4) performed a study involving three different stretching protocols and their effect on the Wingate test performance. Between DS, static stretching, and proprioceptive neuromuscular facilitation, the mean power output was significantly higher after the DS protocol. The current study was conducted to confirm or refute the previous study's result. Since the WAnT is a maximal anaerobic effort, the findings in this study may apply to any sport or activity requiring maximal power

performance. Therefore, the purpose of this study is to examine the effects of a DS protocol on WAnT performance. The hypotheses are as follows: All participants will have a greater increase in RPP and RMP after completing the DS protocol as opposed to the no stretching (NS) regimen prior to the WAnT. When compared to the NS protocol, all participants will exhibit a decreased fatigue index during the WAnT after the DS protocol.

## METHODS

### *Participants*

Ten recreationally-active males volunteered for the present study (see Table 1). Prior to the study, permission to conduct the study was granted by the university Institutional Review Board. All participants read and signed an informed consent form after risks of the experiment were explained. Each participant a Physical Activity Participation Questionnaire to make sure there were no health concerns. Flyers and oral communication were utilized to recruit participants.

**Table 1.** Descriptive characteristics of participants (N =10).

Variable	M ( $\pm$ SD)
Age (yrs)	20.9 ( $\pm$ 1.4)
Body mass (kg)	78.7 ( $\pm$ 12.2)
Height (cm)	177.7 ( $\pm$ 5.5)

### *Protocol*

Participants used a Monark 894E Peak cycle ergometer to complete the Wingate test. A Polar T31 heart rate telemetric device was used to monitor heart rate during the test. Borg's scale was used to measure the Rate of Perceived Exertion (RPE) after the completion of the Wingate test. A Tanita Digital scale model BWB-800S was used to

assess the weight of each participant and a SECA Stadiometer was used to measure height.

Participants were randomly assigned a test order. Each participant completed a familiarization test, a control test, and a treatment test. The testing procedures occurred over a nonconsecutive, three day period. Duration of each session was 15-25 minutes. At the time of sign up, each volunteer was alternately placed into either the control or treatment group for the first test. This was done to ensure a random order. Each participant completed a familiarization test. Each subject then completed his assigned test the following visit. Volunteers completed their final test at their final visit to the lab.

Participants were asked not to consume any alcohol 24 hours prior to each trial and that no food or caffeine products be consumed two hours before testing. There were at least 48 hours between each assessment day. The first day was used to familiarize the volunteer to testing procedures and served as a baseline for the experimental data. The familiarization trial was simply a practice run and consisted of a five minute and 30 second warm-up followed by WAnT. The next two days measured the control and test prescription. Our treatment was the DS protocol.

The warm-up for the control trial consisted of a continuous alternation between resistance cycling (% of WAnT resistance load) and active rest (no resistance at 50 rpm). Resistant load was 7.5% of volunteer's body weight (kg). Participants cycled for one minute with no resistance at 50 rpm, followed by 30 seconds of 25% of

resistant load at 50 rpm. This cycle was repeated two more times while increasing resistance load to 50% and 75%, respectively. Prior studies including, Burnley et al. (2) showed that this type of pre-test loading preps the body for optimal power production during supramaximal exercise.

The warm-up for the treatment trial was the same as the control. After the warm-up, participants performed a variety of dynamic stretches including, walking high knees, running high knees, running butt kicks, and walking lunges over a distance of 40 meters. Each of these stretches target a major muscle group used during the WAnT to include, hip flexors, quadriceps, hamstrings, and gastrocnemius. A similar protocol was used by Han et al. (5), but was modified by eliminating straight leg skipping and skipping high knees and adding walking lunges. The series of dynamic stretches were performed once and took approximately 2.5 minutes to complete. The WAnT followed the dynamic protocol. There were at least two researchers completing the measurements on the subject for each test.

The WAnT involves pedaling a cycle ergometer at a maximal level of exertion (fastest pedal speed) for 30 seconds. It was stressed to all participants that maximal exertion was required for the entire test. Prior to the test, participants performed a 4 minute warm-up by cycling between 50-60 rpm at a resistance that elicited a heart rate between 150-160 bpm. After a 5 minute recovery, a resistance that equaled 7.5% of the body mass (kg) was added to a Monark 894E Sprint cycle ergometer and participants were instructed to pedal the

cycle ergometer at maximal exertion for 30 seconds while staying seated. Revolutions were recorded via a computer to allow for calculation of RPP, RMP, and FI. Relative peak power was calculated by dividing the highest 5-second power output by body mass. Relative mean power was calculated by dividing the average power output by body mass. Lastly, the FI was found by subtracting the lowest power from the highest power and then dividing by the peak power.

#### *Statistical Analysis*

The software we used for analysis of statistics was Statistical Package for the Social Sciences (SPSS) version 21. Means and standard deviations were used for descriptive statics of the sample. One-way repeated measures ANOVAs were used to obtain effect size and compare differences between the control and treatment trials for rate of perceived exertion (RPE), relative mean power (RPP), relative mean power (RMP), and fatigue index (FI).

## RESULTS

All ten participants completed the study. Four one way repeated measures ANOVA's were used to compare the difference in RPE, RMP, RPP, and FI between the DS protocols and the NS regimen trials. There was no significant difference between the NS trial averages and DS trial means on RPE, RPP, and FI. On the other hand, the RMP between DS trial and the non-stretching (NS) protocol were significantly different ( $F(1,9) = 5.55$ ,  $p = .04$ ,  $\eta^2 = .38$ ), with NS trials having a higher RMP when compared to the DS protocol (Table 2).

**Table 2.** Variable differences between dynamic and no-stretching protocols ( $N = 10$ ).

Variable*	Dynamic $M (\pm SD)$	No Stretching $M$ $(\pm SD)$
RPE	15.7 ( $\pm 2.2$ )	15.0 ( $\pm 1.4$ )
RPP ( $W \cdot kg^{-1}$ )	10.0 ( $\pm 1.6$ )	11.4 ( $\pm 2.1$ )
RMP ( $W \cdot kg^{-1}$ )	7.8 ( $\pm 1.2$ ) †	8.5 ( $\pm 0.6$ ) †
FI (%)	50.1 ( $\pm 14.5$ )	57.9 ( $\pm 17.2$ )

Note: \*RPE = rate of perceived, RPP = relative peak power, RMP = relative mean power, FI = fatigue index; † $p < 0.05$

## DISCUSSION

The aim of the present study was to examine the effects of a DS protocol on WAnT performance. DS has been suggested to positively affect power output. We predicted that a DS protocol would increase both RMP and RPP, while decreasing FI. RMP was found to be statistically significant between the two testing protocols, with the NS regimen having a higher RMP output when compared to the DS protocol.

A few researchers have examined the relationship between different stretching protocols and anaerobic performance. These studies have produced conflicting results. Most recently, Franco et al. (4) examined the effects of DS, proprioceptive neuromuscular facilitation, and static stretching on WAnT performance and showed a positive affect of DS on mean power output. In the present study, the mean RMP after the NS regimen was significantly higher than the mean RMP for the DS protocol, in our sample of males. This finding refutes the results found in the study performed by Franco et al. (4). These results also disagree with Turki et al. (8) in regards to DS increasing power output.

Considering the positive effects that DS had on mean power in the past studies, it is possible that a specific component of the current study may have contributed to the divergent findings. One such component could be the lunges exercise that were used as part of the dynamic stretching protocol. The length of stretch may have contributed to a reduction in overall power output secondary to a decrease in the neural input to the muscle. Studies including, Avela et al. (1) and Fowles et al. (3) found that an extended stretching protocol in a muscle group resulted in an acute reduction in performance. It has been shown that prolonged stretching of a specific muscle group reduces the voluntary muscle strength for up to one hour after the stretch was performed (1, 3). The stretched muscles from the lunge may have led to a neuromuscular inhibitory response. This inhibitory response results in a weakening of the muscle and a decrease in muscle responsiveness (3). The lunges may have overstretched the hip extensors, hip flexors, and plantar flexors of the ankle. These muscles are all important for an optimal WAnT performance. Overstretched muscles lead to a decrease in muscle contractility, thus decreasing power output. Future studies should explore the effects of different types and combinations of dynamic stretches. Increasing the pace of the walking lunge to a skip-lunge sequence may help prevent the neuromuscular inhibitory response. Replacing lunges with half-squats in the dynamic warm-up protocol used in the present study may elicit more positive results.

Based on the results reported from previous studies, it could be possible that the dynamic protocol used in the present study

was too strenuous in combination with the initial ergometer warm-up design. Meaning the DS protocol in conjunction with the specialized ergometer warm up design may have fatigued the muscles of the participants. The WAnT is dependent upon these muscles, including gluteus maximus, hamstrings, quadriceps, and the gastrocnemius. Also, allowing time for the participant to recuperate from the DS sequence may prove beneficial in WAnT performance.

Although the mean FI between the NS regimen and DS protocol trial were not significantly different from one another, the mean FI for the NS trial was larger than the mean FI for the DS test. While this is speculation, the lack of significance could be due to the small sample size. Furthermore, one could speculate that if shown to be significant with a larger sample size, this finding would support our hypothesis of DS decreasing fatigue index. If this were the case, it would further validate the need for a DS warm-up before recreational activity or competition. A reduction in the fatigue index after DS could potentially result in an increase in total work capacity, thus an increase in overall performance due to the elevated resistance to fatigue.

The findings from the present study are valuable because they highlight that although DS is heavily used recreationally, competitively, and professionally there may be some combinations and durations of DS that negatively impact power performance. These performance-reducing stretches should be identified and avoided when trying to prepare the body for maximal exercise. Future research should explore

different dynamic stretches, combinations, and duration of stretching that elicit optimal power performance.

Stretching is an essential part of warm-up routines, whether it is to play basketball at the recreational center or to prepare for an event at the Olympics. Some studies have suggested that DS enhances power output. The present study was needed to further explore DS and its effects on power performance. The adverse effects discovered in the present study imply that although DS may be warranted in many warm-ups, there are some stretches that should be avoided if an individual is prepping for an activity requiring power.

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