THE EFFECT OF A "RAPID RESPONSE" NEUROMUSCULAR WARM-UP ON ISOMETRIC FORCE PRODUCTION IN NCAA DIVISION II SWIMMERS

[1]Dustin J. Oranchuk, [1]Zachary J. Switaj [1]Brian M. Zuleger.

[1]Department of Human Performance & Physical Education, Adams State University, Alamosa, Colorado, USA.

INTRODUCTION: The ability to produce large quantities of force quickly is key to the performance of many sports (Stone et al., 2004; Thompson et al., 2003; West et al., 2011). The need to produce these qualities has led to the application of many different means of maximizing force and rate of force development (RFD) through acute and long term protocols. Of the acute interventions, several types of warm-up protocols have been examined including; general warm-ups to increase body temperature, respiration rate, perspiration, and decrease viscosity of joint fluid; dynamic or specific warm-ups to further prepare the body for event specific movements through a variety of drills (Baechle & Earle, 2008); and special warm-up protocols such as post-activation potentiation via the use of Olympic lifts, squats, and resisted sprinting (Naclero et al., 2015). However, the use of "rapid response" warm-ups, which have gained some anecdotal traction through companies such as EXOS and many successful track and field coaches, has a distinct lack of scientific research examining its effects.

The "rapid response" warm-up involves rapid foot movements which are focused on creating quick, powerful ground reaction forces, similar to plyometric training, which is done with the intent of improving motor unit recruitment, synchronization and rate coding (Verkhoshansky & Siff, 2009). These physiological changes then lead to improved force output and rates of force development (Verkhoshansky & Siff, 2009). However, it has yet to be seen if these protocols are superior to more traditional, dynamic warm-ups for stimulating greater strength and power. Therefore, it is the aim of this study to examine the effects of a rapid response warm-up protocol on force and rate of force development outputs.

METHODS: A cross-over study was implemented using 20 (11 male, 9 female) volunteers from the Adams State University swimming team. All participants had at least one year of land-based resistance training experience and had been performing the isometric mid-thigh pull twice/week during the prior four weeks. The mean age, height and body weight were 20.8 ± 3.2 years, 172.6 ± 8.8 cm, and 69.00 ± 10.4 kg respectively. Once the approval from the ASU Institutional Review Board was granted, all participants filled out and signed the necessary consent forms. They were then randomly split into two groups with roughly equal numbers of male and female athletes. On the first day of data collection, the groups were brought into the weight room and run through either a dynamic only warm-up protocol, or a dynamic plus rapid response warm-up protocol (Table 1). Following the respective warm-up protocols, each individual was given two maximal attempts in the isometric mid-thigh pull (IMTP) with a knee angle set between 135-145 degrees, which were separated by three minutes of rest, while standing on Pasco-Scientific (Roseville, California) force-plates sampling at 500Hz. Forty-eight hours later the volunteers returned to the weight-room and went through the opposite warm-up protocol before performing two additional maximal attempts in the IMTP.

The data were analyzed using a paired samples t-test with significance level set at $p<0.05$ to assess changes in relative peak force and peak rate of force development with respect to the given warm-up protocol. Cohen's effect sizes (d) were calculated to measure the magnitude of practical effect, with the following criteria used: 0.2 as small, 0.5 as medium, and 0.8 as large (Field, 2014). Independent sample t-tests with significance level set at $p<0.05$ were run to test the effect of warm-up protocol implementation order and gender differences on both relative peak force and peak rate of force development.

Table 1. Dynamic plus Rapid Response Warm-up Protocol

Dynamic	Rapid Response*
A1: High Knee Skips 2 x 10 meters	B: Base Rotations 2 x 6 seconds
A2: Butt Kick Runs 2 x 10 meters	C: Side to Side Over Line 2 x 6 seconds
A3: Side Shuffle + Arm Swing 2 x 10 meters	D: 2-inch Runs 2 x 6 seconds
A4: Forward Lunge 2 x 10 meters	
A5: Alternating Side Lunge 2 x 10 meters	
A6: Double Arm Circles 2 x 20 each direction	
Rest 15 seconds between exercises	Rest 30 seconds between exercises

*From "EXOS Knowledge" (http://www.coreperformance.com/knowledge/workouts/the-fastest-workout-known-to-man.html)

RESULTS: On average, participants had a higher relative peak force after undergoing a dynamic plus rapid response warm-up protocol (M = 39.80, SE = 0.86) verses a dynamic only warm-up (M = 37.82, SE = 0.92) (Table 2, Figure 1). This difference, 1.98 N/kg, was significant $t(19) = -3.875$, $p = 0.001$, and represented a medium effect size, $d = 0.48$. Participants were also found to have a higher peak rate of force development after utilizing the dynamic plus rapid response protocol (M = 6013.3, SE = 316.1) than after the dynamic only warm-up (M = 5555.7, SE = 263.8) (Table 2, Figure 1). This difference, 457.5 N/s, was also significant $t(19) = -3.166$, $p = 0.005$, and represented a small-to-medium effect size, $d = 0.39$.

Table 2. Peak Force & Peak Rate of Force Development: Dynamic vs Rapid Response Warm-up

	Peak Force (N/kg)		Peak RFD (N/s)	
Warm-up Protocol	Dynamic	Rapid Response	Dynamic	Rapid Response
Mean	37.82	39.80*	5556	6013*
SD	4.10	3.84	1180	1414

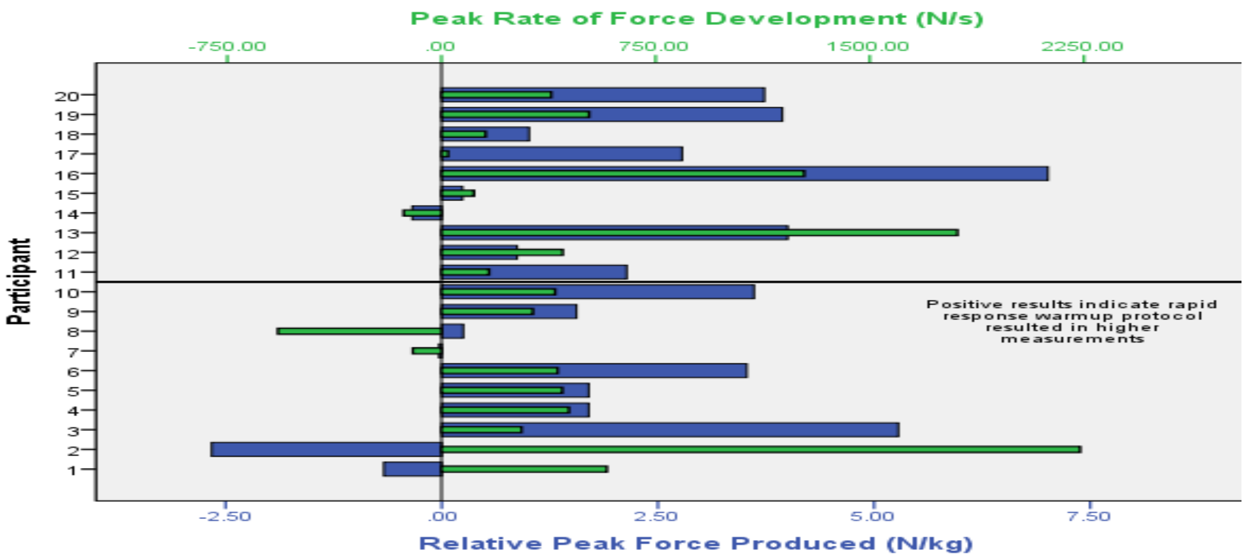
*Denotes a significant difference from dynamic warm-up protocol ($p < 0.05$)

DISCUSSION: The statistical analysis of this study showed that the addition of a rapid response warm-up to a dynamic warm-up resulted in a significant increase in both peak force (PF) and peak rate of force development (PRFD) during the IMTP, in NCAA Division II swimmers when compared to a dynamic only warm-up. However, total warm-up volume/duration was not controlled, so extending the warm-up period, not specifically performing the rapid response protocol, could have been responsible for the performance increases.

Increases in PF and PRFD have been shown to have a strong relationship with improved results in many sports, specifically those which involve brief, maximal effort movements such as sprints, throws, or jumps (Stone et al., 2003). For this reason, the rapid response warm-up has been used anecdotally to improve performance in these types of events. In addition to the potential performance enhancing effects of the rapid response warm-up, the protocols, including the one used in this study, often only take three to five minutes to complete. This short time frame only strengthens the cost-benefit ratio, as even non-responding individuals will have only spent an additional three to five minutes preparing for their event(s). Another benefit of the rapid response warm-up is that it can be completed nearly anywhere as it requires no additional equipment beyond a flat, solid surface, and proper footwear.

In conclusion, the rapid response warm-up seems to have potential to acutely improve force production and RFD in athletes; however, peer-reviewed evidence is severely lacking. Future studies and projects would likely be best served by focusing on athletes that require high levels of relative strength and explosiveness such as sprinters, jumpers and throwers as well as better controlling total warm-up volume/duration between groups.

Figure 1. Individual Change in PF and PRFD from Dynamic to Rapid Response Warm-up



REFERENCES:

Baechle, T. R., & Earle, R. W. (2008). *Essentials of Strength Training and Conditioning* (3rd Ed). Champaign, IL: Human Kinetics.

Field, A. (2014). *Discovering Statistics using IBM SPSS Statistics (4th Ed).* New Delhi, India: SAGE Publications.

Naclero, F., Chapman, M., Larumbe-Zabala, E., Massey, B., Neil, A. & Triplett, N. (2015). Effects of three different conditioning activity volumes on the optimal recovery time for potentiation in college athletes. *Journal of Strength & Conditioning Research, 29*(9), 2579-2585.

Stone, M. H, Sanborn, K., O'Bryant, H. S., Hartman, M., Stone, M. E, Proulx, C., Barrymore, W. & Hruby, J. (2003). Maximum strength-power-performance relationship in collegiate throwers. *Journal of Strength & Conditioning Research, 17(*4), 739-745.

Stone, M. H., Sands, W. A., Carlock, J., Callan, S., Dickie, D., Daigle, K., Cotton, J., Smith, S. L. & Hartman, M. (2004). The importance of isometric maximum strength and peak rate-of-force development in sprint cycling. *Journal of Strength & Conditioning Research, 18*(4)*,* 878–884.

Thompson, B., Ryan, E., Sobolewski, E., Smith, D., Akehi, K., Conchola, E. & Buckminster, T. (2013). Relationship between rapid isometric torque characteristics and vertical jump performance in division I collegiate American football players: Influence of body mass normalization. *Journal of Strength & Conditioning Research, 27*(10), 2737-2742.

Verkhoshansky, Y. & Siff, M. (2009). *Supertraining* (6th Ed). Ultimate Athlete Concepts.

West, D., Owen, N., Jones, M., Bracken, R., Cook, C., Cunningham, D., Shearer, D., Finn, C., Newton, R., Crewther, B. & Kilduff, L. (2011). Relationship between force-time characteristics of the isometric midthigh pull and dynamic performance in professional rugby league players. *Journal of Strength & Conditioning Research, 25*(11), 3070-3075.