The Effects of Static Stretching Warm-up Versus Dynamic Warm-up on Sprint Swim Performance

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Abstract

Recent research has revealed that static stretching (SS) warm-ups may attenuate power performance compared to dynamic protocols, but most studies have focused on dry land modalities. This study examined the effects of an SS warm-up versus a dynamic warm-up (DW) on freestyle sprint performance in competitive swimmers. Using a crossover design, 16 NCAA Division 1 swimmers swam a 50-meter freestyle sprint after two different warm-up protocols that were designed to mirror typical practice among competitive swimmers, while allowing any practically significant experimental effects from the SS versus DW contrasts to occur: Specifically, the warm-ups were Static Stretch + Swim (SS/S), and Dynamic Warm-up + Swim (DW/S). In each case the contrasting experimental warm-up exercises (nine static stretches versus nine dynamic movements) were immediately followed by a typical swimming warm-up (about 20-minutes). The timed 50-meter sprints took place 5-minutes after the SS/S and DW/S warm-ups, and they were conducted three days apart under simulated competitive conditions. In separate analyses there were no significant differences in mean times over the first 25 meters, the second 25 meters, or the overall 50-meter sprint time. Thus, in contrast to the effects shown in many other performance modalities, SS in warm-up did not attenuate performance in this study. It is possible that the swimming warm-up done subsequently to the SS or DW component may have blunted any SS-induced performance deficits. Thus, future research might vary the swimming component of warm-up to see if any effects of SS versus DW emerge.

Introduction

Warm-up procedures before physical activity have long been used with the intention of preparing athletes for subsequent strenuous exercise (Schilling, 2000; Mann and Jones, 1999). These procedures have been chosen by many coaches because they have been assumed to reduce the risk of injury, improve range of motion, decrease muscle soreness and have a positive effect on performance (Alter, 1998; Ninos, 1995; Young and Elliott, 2001; Yamaguchi and Ishii, 2005). These performance-related assumptions have recently been

supported by a systematic review with meta-analysis that concluded that warming up generally does improve performance, including swimming performance (Fradkin, Zazryn and Smoliga, 2010).
However, for several years, evidence that questions the use of static stretching before strength and power activities has been accumulating. This evidence has led some researchers to state that "…it seems justifiable to exclude this component from the warm-up for strength and power activities." (Young and Behm, 2002, p. 35). Perhaps because research evidence is not often effectively disseminated to practitioners, or because the evidence is not conclusive, many coaches are unsure about the best way to warm-up their athletes. Some believe that static stretching is effective, while some coaches believe that a more dynamic warm-up, using movements mimicking those during exercise will be more effective (Young and Behm, 2002; Mann and Jones, 1999).
Although several studies have contrasted types of stretching, or compared stretching with dynamic warm-ups before *dry land* athletic performance, little peer reviewed research could be found in the published literature that specifically tested the different protocols on swimmers, especially on elite level swimmers. One study (Bobo, 1999) did compare static stretching along with a swimming warm-up against bench pressing along with a swimming warm-up on 100 yards swim time—but no differences were found. Also, a recent study (Neiva et al., 2011) showed that "typical" dry land warm-up procedures and about 1,000 meters swimming, did improve power output in tethered front crawl swimming in young adolescent swimmers, but no details of the dry land component of the warm-up were given.
Thus, the purpose of this study was to investigate if typical static stretching versus dynamic muscle activities as part of a pre-sprint swim performance test warm-up would produce different results in elite level swimmers. Given the evidence from such contrasts before dry land sprint tests, it was hypothesized that the inclusion of static stretches would lead to slower times than the inclusion of dynamic muscle activities.

Methods

Participants

A total of 16 swimmers (5 female, 11 male) from an NCAA DI swim team were recruited to participate. These swimmers had recently completed their collegiate season. All participants gave their informed consent to take part following the policies of the university Institutional Review Board.

Warm-up Protocols

Participants were randomly assigned to either the dynamic warm-up (DW) group or the static stretch (SS) group. Each group completed the DW or SS in an adjacent gymnasium, and then swam the in-water portion of the designated warm-up before doing the timed sprint swims. The respective warm-up protocols are described in Table 1 below:

Table 1. Dynamic Warm-Up, Static Stretching, and In-Water Warm-up Protocols

DW Activities	Description (all dynamic activities were done over 10-yards with a short rest between)
Speed Skips	Rapidly skip forward.
Heel-ups	Rapidly kick heels towards buttocks while moving forward.
In and Out	Rapidly turn toes in/heels out and toes out/heels in while hopping forward
Trunk Twists	With arms behind head and body erect, rapidly hop forward as hips are turned to one side then the other, focusing on trunk rotation.
Skipping Toe Touches	With arms extended in front of the body, lift one foot toward the extended arms and then skip as the extended leg returns to the floor and the other leg is lifted.
Drop Squat/Carioca	From a standing side stance, hop and land with feet at shoulder width and body lowered to semi-squat position; move laterally while rapidly crossing feet over each other.
Power Pushups	After performing 3 pushups, perform 3 power pushups by quickly pushing your upper body off the ground and clapping your hands.
Sprint Series	While standing erect, fall forward and begin to sprint to the 5-yard mark, then accelerate as fast as possible through the 10-yard mark.
High Knee Skip	While skipping, emphasize high knee lift and arm action.

Static Stretches	Description (Each static stretch was held at point of mild discomfort for 30-seconds, then repeated again once after a 5-second rest)

Hip and Low Back	In a seated position with one leg extended, cross the other leg over the extended leg; wrap arms around crossed leg and pull towards chest.
Chest	In a standing position, place both arms behind the back, clasp hands together and lift arms upwards.
Quadriceps	While lying on your side with body erect, bend top knee and hold the foot with one hand while pulling foot towards buttocks.
Calf Stretch	In a standing position with feet staggered about 2-3 feet from a wall, place both hands on wall and lean forward; keep the back leg straight with heel to floor and the front leg slightly bent.
Horizontal Flexion I	With a straight elbow, thumb pointed upwards and the palm facing the body, exhale and reach arm towards top of opposite shoulder. Use the opposite hand to assist at the end of the elbow.
Horizontal Flexion II	Reach around to opposite side of neck. Place hand on top of shoulder, raise elbow to shoulder height without elevating shoulder of arm. Walk fingers down the upper back as far as possible.
Triceps	With elbow flexed at 90 degrees in front from vertical position, move flexed arm as far upwards as possible.
Hyperextensions	With palms facing upwards, reach both arms backward as much as possible and have a partner extend the arms upwards.
Hamstring Stretch	In a seated position with both legs extended straight out, grab the legs with hands and extend upper body as far forward as possible.

In-Water Warm-Up (Meters)

600 easy freestyle swim

8 x 50 freestyle on 1:15

#s 1-4: Drill/Swim by 25's

#s 5-8: Swim

200 Kick

4 x 50 Kick on 1:20

4 x 100 freestyle on 1:45 (build the last 50 to fast)

8 x 25 freestyle on 1:00 (15 sprint, 10 meter easy swim)

2 x 25 freestyle sprint from blocks

100 easy freestyle swim

50-Meter Timed Freestyle Sprint Test

The actual sprint test was conducted following a five minute break after the warm-up protocol was completed from each group. The sprint test involved the participant swimming a total of 50-meters freestyle. Because of the design of the bulkhead at the 25-meter turn, the electronic touch pads could only be mounted high on the wall. Consequently, each participant was instructed to make an "open, hand touch" turn after the first 25 meters freestyle rather than the usual tumble turn. The Daktronics computer system captured the first 25 meter time, the second 25 meter time and the overall finish time. One swimmer did not receive a time in one condition due to an equipment fault, so the sample was reduced to n = 15.

Study Design

The experimental sequence is shown in Figure 1 below:

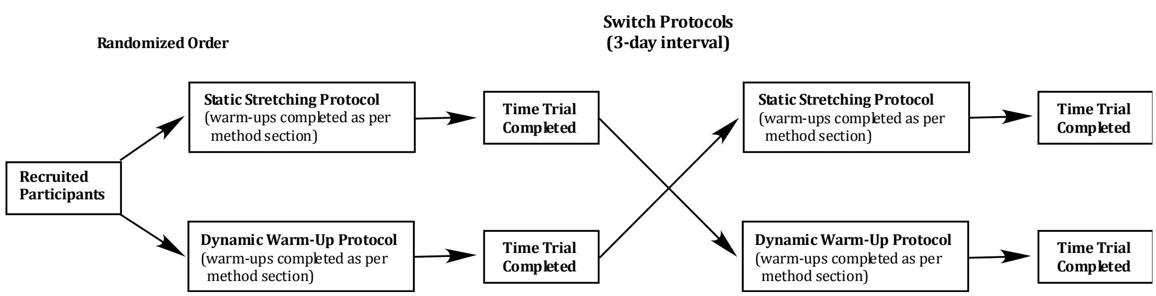

Figure 1. Study sequence and design

Results

Initial paired *t*-tests were computed to check if the order of trials had any effect on performance. There were no significant effects. Paired *t*-tests were then used to test for effects of static stretching versus dynamic warm-up on times for the first 25 meters, second 25 meters, and the overall 50 meter sprint. There were no significant differences in any of the three comparisons (see Figure 2 below).

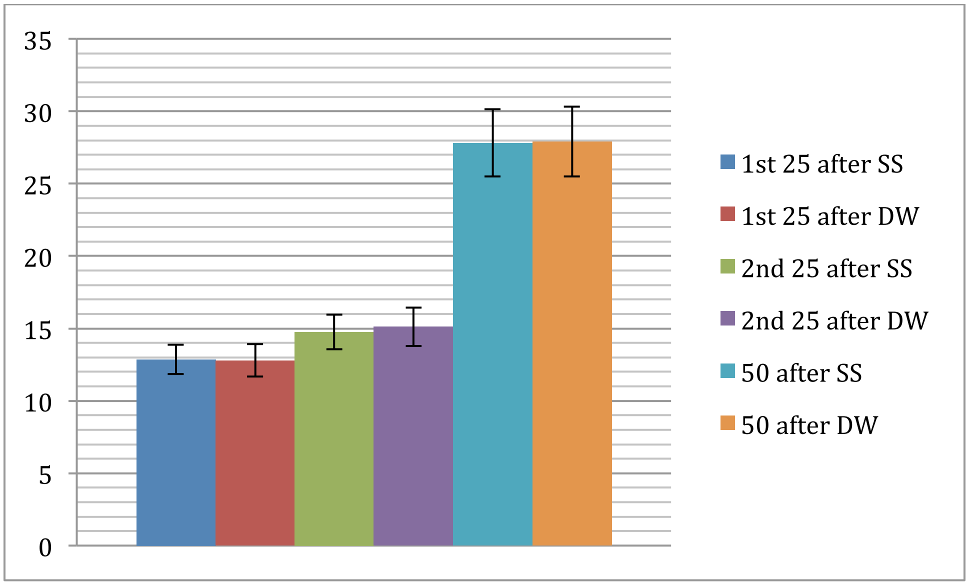

Figure 2. Sprint freestyle times in each condition

Each individual swimmer's time difference between the 50-meter sprint after static stretching versus dynamic warm-up is shown in Figure 3 below.

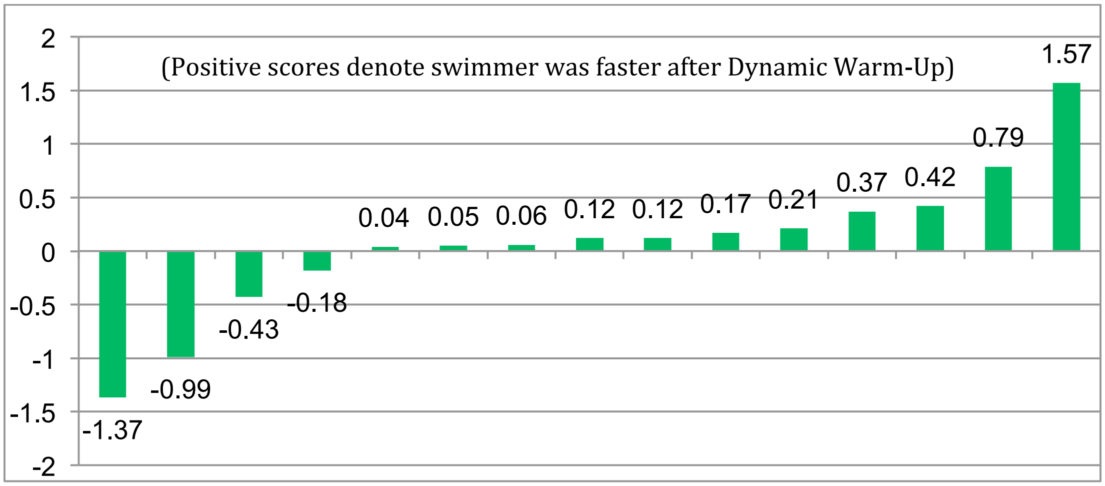

Figure 3. Individual time differences between 50-meter sprint trials

Discussion

Studies of the effects of warm-up on performance continue to emerge, and they generally indicate that dynamic warm-ups improve explosive performance (e.g., Turki et al., 2012) whereas static stretching warm-ups impair it (e.g., Haddad et al., 2013). This study was a field experiment designed to investigate if the typical impairing effects of static stretching on dry land power performance, would also be seen in swimming—specifically, when the stretching was part of a warm-up for a 50-meter freestyle sprint. Since no significant performance differences were found, it is possible that SS does not attenuate sprint performance in swimming (or is similarly as efficacious as DW). However, these results should be seen as provisional in light of the strengths and weaknesses of this study.

The strengths of the study include the sample (D1 level college swimmers), and its ecological validity (done under competition-type conditions). However, given the individual variability in results, and because of some other potential confounds, it may be that the results were affected by other factors.

For example, it was realized after the study was conducted that there was more of an upper body focus in the SS intervention compared to the DW condition. Theoretically, this could have affected results both positively (e.g., possible better range of movement in SS condition), or negatively (e.g., greater stretch-induced performance deficits in SS condition). Without empirical data it could only be conjecture to question whether the greater arm focus in the SS condition affected the results, but future studies should certainly try to balance the focus on the various muscle-joint complexes in the warm-ups.

Perhaps a more important factor was that all swimmers did a typical swimming warm-up *after* the SS or DW interventions (see Fig. 1). This sequence was designed to maximize ecological validity for the field study, but it is possible that the swimming warm-up may have negated ("washed out") any effects of the prior SS or DW. This possibility might explain why the older study by Bobo (1999) also found no effects on 100-yard sprint times. Moreover, a meta-analysis that was published after this study was completed (Simic, Sarabon, & Markovic, 2013) has clarified the dose-response performance deficits after acute SS, and its authors recommended that SS not be the sole activity of a warm-up routine. They also went on to comment that: "…its incorporation into a comprehensive warm-up could be a possible practical solution that would minimize the negative acute effects of SS on performance, while still keeping its potentially positive effects." (p. 143). The inference of this practical suggestion would seem to be that coaches who wish to continue using SS as part of warm-ups should restrict the duration of the stretches, and also take care not to have swimmers perform them as the last warm-up activity immediately before their competitive races.

While every attempt was made to maximize ecological validity of the study, it was not possible to conduct it during the swimmers' competitive season. Not only was it difficult to find a time when training-related fatigue would not have been an issue, but neither the swimmers nor the coaches wanted the distraction of research participation during the competitive period. Thus, the study was

conducted post-season when the swimmers were not in regular training, and consequently, some inconsistencies may have occurred because of variability in fitness and competitive motivation. The individual variability between the two 50-meter trials (see Fig. 3) certainly suggests that some of the swimmers may not have been as focused upon their performance as they would if it were a genuine competitive effort. Of course, that possibility is only conjecture given that no qualitative or quantitative attempts to assess motivation were made.
As mentioned in the Method section, because of the design of the bulkhead at the 25-meter turn, the electronic touch pads could only be mounted high on the wall. Thus, the swimmers did not utilize a normal flip turn (which might have missed the pad), but were instructed to use a hand touch instead, and this unfamiliar skill may have affected the results. Whether such an effect could have obscured any experimental effect (as opposed to introducing random error) can also only be conjectured—although the very small mean differences between trials (see Fig. 2: 1st 25 diff. = .09 sec; 2nd 25diff. = .35 sec; 50 diff. = .09 sec) suggest to the authors that random error is most likely.

Conclusion

In summary, the results of this study did not provide evidence of deleterious effects of SS, (or less efficacious benefits compared to DW) on sprint swim performance. However, replications of the study which avoid the weaknesses of this field experiment are needed before any firm conclusions about the effects of SS versus DW on sprint swimming performance can be made with confidence.

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