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Original Article

The effect of different duration of dynamic stretching on sprint run and agility test on female gymnast

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Summary

Stretching is an integral part of warm-up activity in sports to enhance athlete's performance. The main purpose of the study was to compare the effects of different dynamic stretching duration on speed and agility performance in female gymnasts. A cross-over, repeated-measures design was conducted with participants performed five experimental protocols in a random order. The stretching protocols consisted of four different stretching exercises designed to stretch knee extensors, knee flexors, hip extensors, and plantar flexors. All stretches were performed by both legs in an alternate fashion. Participants assessed on Sprint run 20 m and Agility Performance. Significant interaction effect between protocols and time was found for 20 m sprint and agility performance. Further, statistically significant main effect was found for time for the aforementioned variables. The post hoc comparisons revealed significant differences between pre and post measurement on 20m sprint for dynamic stretching 20 and 30 sec; and 20 up to 40sec for agility performance. Overall, the results revealed that dynamic stretching provide significant benefits for improvement explosive performance skills such as 20 m sprint run and agility performance

Key words: stretching, performance, speed, agility, gymnastics

Introduction

Stretching is an integral part not only of the warm-up, but also the training and competitive performance of athletes. The positive effect on athletic performance is well documented, thus increasing core body and muscle temperature (Yamagushi & Ishii, 2005), muscle flexibility (Young, 2007), alteration in muscle-tendon unit (MTU) stiffness, post-activation potentiation (PAP), and decreasing the risk of injury (Woods et al., 2007; Young and Behm, 2002). For that reason, athletes on various sports use different types of stretching, such as static stretching (SS), dynamic stretching (DS), and proprioceptive neuromuscular facilitation stretching (PNF) (Young and Behm, 2002). The effect of SS has been extensively examined with regard to the effects on parameters related to athletic performance (Avloniti et al, 2016; Beckett et al, 2009; Behm and Chaouachi, 2011; Chaouachi et al, 2010; Paradisis et al, 2014; Young and Elliott, 2001). Athletes during warm-up for sport activities that require explosive performance incorporate dynamic stretching (DS) (Judge et al, 2013) to enhance active flexibility. DS involving controlled movement through the active range of motion (ROM) for joint, performing movements that are specific to the activity that the individual is preparing (Behm and Chaouachi, 2011). Previous findings support that DS improve jumping performance (Manoel et al., 2008; Perrier et al., 2011), sprint time (Gelen, 2010; Fletcher and Anness, 2007; Fletcher and Jones, 2004; Galazoulas, 2017), and agility (Chatzopoulos et al, 2014; Little and Williams, 2006; McMillan et al, 2006; Van Gelder and Bartz, 2011). The aforementioned studies have examined the effect of different DS duration on athletic performance as separate conditions (in isolation) with conflicting results. Chaouachi et al. (2010) applying, on highly trained, non-sprint-trained, university age physical education students, DS separately or in conjunction with SS found that DS, did not improve nor impede performance. Furthermore, previous findings of Yamaguchi and Ishii. (2014) report that optimal protocols of DS to improve explosive performance should be performed "as fast as possible finally" and "10-15 repetitions" or "10 yards to 20 m" in distance x "1-2 sets". The superiority of DS to SS is due to mechanisms related to an increase in temperature within the muscles such as a reduction in joint and muscle stiffness, greater nerve impulse conduction rate, force velocity relationship alterations (McMillian et al, 2006).

The majority of the literature has examined the effect of DS in adolescent female high school athletes (Chatzopoulos et al, 2014) or high-trained male individuals (Chaouachi et al, 2010) or compare different stretching methods e.g. SS vs DS. To the author's knowledge, no study has investigated the effects of various DS duration on speed and agility performance according to a cross-over, repeated-measures design with the same participants completing all experimental conditions. Hence, the purpose of the present study was to

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compare (a) the effects of different DS duration on speed and agility performance in female gymnasts. It was hypothesized that short duration (10, 20 sec) DS protocols would be more effective than moderate duration (30, 40 sec) for improvement sprint run and agility test and that DS would result in enhanced performance compared with No stretching protocol (control).

Material and Methods

Participants

Twenty six, female gymnasts that come from various types of gymnastics (artistic, rhythmic, recreational) with a mean age 22.42 ± 3.65 years; weight 57.82 ± 6.63 Kg, height 165.03 ± 4.51 cm volunteered to participate in this study. Inclusion criteria included: (a) absence of any musculoskeletal injury for at least 6 months, and (b) lack of physical exercise for at least 48 hours prior to the execution of each protocol. The study conformed to the Declaration of Helsinki and the study protocol was approved by Ethical approval was gained from the Research Ethics Committee of the National and Kapodistrian University of Athens, School of Physical Education and Sports Science. Each participant after receiving a detailed verbal and explanation of the study's benefits and risks provided written informed consent before commencement of the study.

Procedures

To test the hypothesis of this study, the effects of 4 DS protocols duration on sprint and agility performance, a cross-over, repeated-measures design was conducted. The participants performed 5 experimental protocols, at the same time of the day, in a random order (figure 1). Each protocol included a 3-minute warm up running on the treadmill at 2.22 m . s -1, followed a 2-minute rest. A within-subject experimental design was used with all the participants completing the DS and control (no stretching: control) protocols randomly. Participants attended a total of 6 data collection sessions including a 1-familiarization session. The familiarization period was applied 5 days before the inception of the DS protocols to avoid a learning effect on performance including the DS technique and the two performance tests (sprint run, and agility T-test). The remaining 5 sessions were completed during the course of the subsequent 10 days so that approximately 48 hours separated each test day in order to minimize any performance changes that could occur over a longer time period. The order of the warm-up protocol assignment and the tests were counterbalanced per person and per day to avoid carry over effects. All data collection and testing occurred in an indoor gymnastic court of the School of Physical Education and Sport Science to eliminate wind resistance or inclement weather. A two minute rest was provided between the end of the warm-up and the beginning the performance testing.

Anthropometric profile. Body mass was measured to the nearest 0.5 kg (Seca 710, Birmingham, United Kingdom). Standing height was measured to the nearest 0.5 cm (Seca stadiometer 208).

***Dynamic stretching*:** The participants performing DS contracted the antagonist of the target muscles intentionally in an upright standing position and flexed or extended the relevant joints once every 2 seconds for each leg alternatively for a certain length of time depending on the duration of each protocol. The next muscle group was flexed after a resting period of 20 seconds. The sequence of the stretched target muscle and the resting periods were identical. The stretching protocols consisted of four different stretching exercises designed to stretch knee extensors, knee flexors, hip extensors, and plantar flexors. All stretches were performed by both legs in an alternate fashion. An analytical description of the stretching exercises is presented in table 1.

Table 1

Dynamic stretching exercises

Quadriceps: The participants contracted their hamstrings intentionally and flexed the knee joint so that the heel touched their buttocks.

Hamstrings: The participants contracted the hip flexors intentionally with the knee extended and flexed their hip joint so that the leg swung up to the anterior aspect of the body.

Hip extensors: The participants contracted hip flexors intentionally with the knee fixed and flexed their hip joint so that the thigh came up toward the chest.

Plantar flexors: Initially, the participants raised 1 foot and fully extended the knee. Then, they contracted their dorsi flexors intentionally and dorsi flexed the ankle joint so that the toes were pointing upward.

No stretching (control): The participants sat for 3 minutes and did not perform any stretching.

20 m Sprint run

20m Sprint run was performed from a standing start position. The time of 20 m was obtained using the Brower timing systems (Brower, USA). Two pairs of photocells were placed within 20 m distance. The first pair was placed at the starting line (0 m) and the second at the finish line (20 m). Each participant started running from the upright position 50 cm before the first pairs of photocells, and tried to run as fast as possible passing the finish line (second pairs) without reducing speed.

T-Test (agility test).

The T-test is a simple fitness test to determine someone's agility, by measuring how quickly can change direction accurately. The more agile the participant the quicker he/she can complete the T test. Score was recorded to the nearest 0.01 second. The T test was used to determine speed with directional changes such as forward sprinting, left and right side shuffling, and backpedaling.

At baseline (pre-values) and at the end of each DS protocol, participants completed sprint run and agility testing. Participants performed the two tests (sprint and agility) in a random order twice with a 3-minutes rest between trials. During the recovery period of 3 minutes, the subjects walked back to the starting line and then waited for the next sprint.The best score was used for further statistical analysis

Statistical analysis

The statistical package SPSS (v. 24) was used for the statistical analyses. A 2-way (time * protocols) repeated measures analysis of variance was used to examine the effect of time (pre-stretching and post-stretching) and protocols (DS_{10}, DS_{20}, DS_{30}, DS_{40}, CONTROL) on the dependent variables. Sphericity was checked using Mauchly's test, and the Greenhouse-Geisser's correction on degrees of freedom was applied when necessary. In cases where interaction between time and protocols was detected, the simple effects were investigated, and Bonferroni's correction was used. In the absence of interaction, the main effects of the 2 factors (time and protocols) on the dependent variables were investigated. The Interclass coefficient (ICC) between pre testing and post testing for sprint run 20 m test were 0.93 and 0.96, for agility T Test were 0.91 and 0.95. All statistical significances were tested at a = 0.05.

Results

Descriptive statistics of the dependent variables are presented in table 2. No significant differences were found on pre-test DS protocols (p > .05). The statistical analysis for the 20- sprint revealed significant interaction effect between protocols and time on speed performance ($F_{(4)} = 12.471$, $p < .001$, $n^2 = .694$, power = 1.000). Further, statistically significant main effect was found for time ($F_{(1)} = 8.319$, p <01, $n^2 = .250$, power = .792). However, no significant main effect was found for protocols ($F_{(4)} = 1.127$, $p > .05$, $n^2 = .369$, power = .295). The post hoc comparisons revealed a significant differences between pre and post measurement on DS 20 (p < .001) and DS 30 sec (p <. 005) and control (p < .05).

Significant interaction effect was found between protocols and time on agility performance ($F_{(4)} = 4.799$, $p < .01$, $n^2 = .466$, power = .901. Significant main effect was found also for time ($F_{(1)} = 30.447$, $p < .001$, $n^2 = .549$, power = 1.000). However, no significant main effect was found for protocols ($F_{(4)} = 1.285$, $p > .05$, $n^2 = .189$, power = .334). The pairwise comparison revealed a significant improvement in post measurement on DS 20 (p < .001) DS 30 (p < .005) and DS 40 (p < .05) compared to pre values.

Table 2

20m sprint run and agility values on the various protocols. Values are mean (±SD)

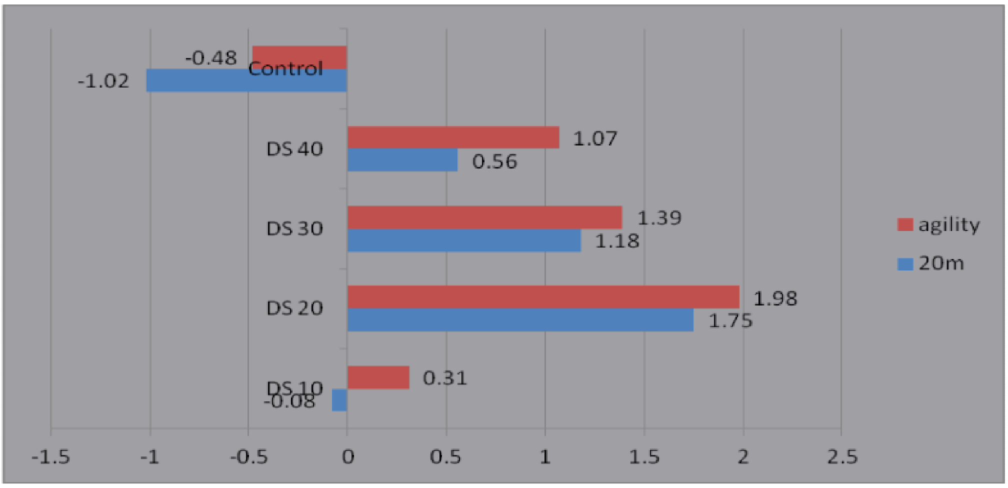
Duration (sec)	20m sprint run PRE	POST	Agility T-test (sec) PRE	POST
10	3.749 ± 0.20	3.752 ± 0.19	13.190 ± 0.84	13.149 ± 0.87
20	3.778 ± 0.23	3.713 ± 0.22 #	13.093 ± 0.59	12.838 ± 0.60 #
30	3.755 ± 0.21	3.711 ± 0.19 #	13.214 ± 0.50	13.033 ± 0.41 #
40	3.746 ± 0.20	3.725 ± 0.21	13.141 ± 0.51	13.001 ± 0.59 #
Control	3.761 ± 0.18	3.800 ± 0.21 #	13.196 ± 0.89	13.260 ± 0.97

Significant differences compared to pre values p < .05

A significant improvement (p <. 05) for 20 m speed was found in response to 20 and 30 second DS protocols in post measurement as compared to pre values (1.75% and 1.18% respectively) . Further, significant impairment (p < .05) was found for no stretching (control) protocol (figure 1). Agility performance revealed a significant improvement in DS 20 (p<.001), 30 (p<.05), and 40 second (p<.05) (1.98%, 1.39% and 1.07% respectively).

Figure 1

Percentage post difference of DS duration on 20m speed and agility performance compared to pre values.



Discussion

The purpose of the present study was to investigate the acute effects of different duration of DS on running speed and agility performance in female gymnasts. Results revealed that DS elicits the best performance in speed and agility tests. Specifically, results showed that the effects of DS exercises on speed and agility performance may be duration dependent. The initial hypothesis that short duration DS (10, 20 sec) would be more effective compared to moderate duration DS was rejected.

DS duration 20 and 30 seconds produce significant improvement on running speed 20 m, whereas DS duration by 20 up to 40 seconds produce significant improvement on agility performance. Furthermore, DS duration more than 10 sec are more effective in speed 20m and agility performance compared to the control condition. The results are in congruence with findings by other authors (Fletcher and Jones, 2004; Gelen, 2010; McMillian et al, 2006) who found significant improvement in sprint run test after DS. However, our results opposed of those of Chaouachi et al. (2010) who found that DS did not improve nor impede sprint performance and those of Paradisis et al. (2014) who found a reduction by 0.8%. Nevertheless, the study by Chaouachi et al. applied 2 set * 30 sec duration in high-trained male students and Paradisis et al. applied 2 set * 20 sec in adolescent boys and girls. Nevertheless, it is worth noting that short duration DS (10sec) have a detrimental effect on speed running 20m. The differences observed in the aforementioned mentioned studies are due to the different testing method such as the type of DS exercise, targeted muscle groups, volume and intensity of stretching, sports experience level and the training status of the subjects, (Behm and Chaouachi, 2011).

In relation to agility, results of the present study revealed that DS significantly improves the performance compared to control condition (no stretching). However, it is worth mentioning that irrespective of the duration of the stretch all DS protocols produces lower values in agility test that mean an improvement of agility performance. This finding is in congruence with previous studies that showed an improvement in agility performance (Chatzopoulos et al, 2014, McMillian et al, 2006; Troumbley, 2010; Vaghela and Parmar, 2015; Van Gelder and Bartz, 2011). Authors suggest that the improvement on agility performance may be attributed a) to the post-activation potentiation phenomenon (PAP) due to increased muscle efficiency to produce force after a maximal or submaximal contraction (Chatzopoulos et al, 2007), and b) the increase in muscle temperature which reduces muscles resistance (Fletcher and Monte-Colombo, 2010) contributing to a more dynamic muscle contraction and a faster relaxation (Shellock and Prentice, 1985).

Conclusions

The current results support that DS moderate durations (20-40 sec) provide significant benefits for improvement explosive performance skills such as 20 m sprint run and agility performance. Based on the present study sprinting run and agility are positively affected if DS precedes these skills, thus these tasks seems to be optimized by the use of DS in warm-up. Thus, trainers and gymnasts recommended including DS in warm-up to improve both sprint run and agility performance.

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