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Original Article

Acute effect of specific warm-up exercises on sprint performance after static and dynamic stretching in amateur soccer players

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Abstract:
The purpose of the present study was to investigate the role of specific warm-up in soccer on 20 m sprint after static and dynamic stretching in a sample of 16 healthy amateur soccer players, aged 21,41±3,28 years. All participants performed on different days and in random order, a warm-up program that included general warm up, static or dynamic stretching of lower extremities, a specific warm-up of the sport and three measurements of 20 m sprint. The first sprint measurement was made after the general warm up, the second after the static or dynamic stretching and the third after the specific warm-up. The time of sprint was measured by photocells. The results of the study showed a decline of the sprint time after the static stretching protocol ($p<0.05$) and reversal ($p<0.005$) after the application of the specific part of the warm-up. The results also showed that the sprint performance is not affected neither positively nor negatively, after the implementation of dynamic stretching protocol and the specific warm-up that follows. It is concluded that the specific soccer warm-up which is applied to the third part of the warm-up, not only eliminates the negative effects caused by static stretching on sprint, but also improves the performance in amateur soccer players. Moreover this type of warm-up does not affect the sprint after the dynamic stretching.
Keywords: specific warm-up, static stretching, dynamic stretching, sprint, soccer

Introduction

Warm – up is an integral part of the training process and the game in the team sports, especially in soccer. In this sport, traditionally, the warm-up tends to include the general part, dominated by low intensity aerobic efforts designed to increase the body and muscle temperature of the players and to improve neuromuscular function, (Behm & Chaouachi, 2011; Fradkin, Zazryn and Smoliga, 2010; Young & Behm, 2002) and the specific part, which contains motor actions of the game (Behm & Chaouachi, 2011; Fradkin et al., 2010; Young & Behm, 2002), aiming to execute game movements more economically, with a higher intensity and a better neuromuscular coordination, due to the improvement of speed transmission of the nerve impulses (Hedrick, 2000). Between the general and the specific part of the warm-up the players tend to apply flexibility training to prevent injuries (Safran, Seaber & Garrett, 1989), to optimize performance (Van Gyn, 1984) and to improve the range of motion (ROM) of the joints (Shellock & Prentice,1985). To improve the ROM of the joints, the most popular type of muscle elongation in soccer practice is the technique of static stretching (Hedrick, 2000; Yamaguchi & Ishii, 2005), although in recent years the dynamic stretching occupies greater area in the training process (Faigenbaum, McFarland, Schwerdtman, Ratamess, Kang, και Hoffman, 2006; Hedrick, 2000; Needman, Morse, και Degens, 2009; Yamaguchi & Ishii, 2005).

Although players tend to apply the static stretching to improve flexibility and performance and to prevent injury risks (Van Gyn, 1984; Shellock & Prentice,1985; Safran, et al, 1989), as mentioned above, some researchers however, find decreases in the vertical jump and the power of the lower limbs (Faigenbaum et al., 2006; Fletcher & Monte-Colombo, 2010; Pearce, Latella & Kidgell,2011), the muscle strength (Fowles, Sale and McDougall, 2000; Power, Behm, Cahill, Carroll and Young, 2004), and the sprint (Chaouachi, Chamari, Wong, Castagna, Chaouachi, Moussa-Chamari and Behm, 2008; Fletcher & Jones, 2004; Fletcher & Monte-Colombo, 2010; Gelen, 2010; Needman et al., 2009; Sayers, Farley, Fuller, Jubenville, Caputo, 2008; Winchester, Nelson, Landin, Young, Schexnayder 2008; Papadopoulos, Ispirlidis, Kyranoudis, Alipasali, Famisis, Giannakos, Galazoulas, Zakas, 2015; Famisis,2015) as opposed to the muscle elongation with dynamic way that seems to improve the performance on power efforts (Faigenbaum et al., 2006; Fletcher & Monte-Colombo, 2010; Needman et al., 2009; Galazoulas,2017), on muscle strength (Yamaguchi & Ishii, 2005) and the sprint (Fletcher & Jones, 2004; Fletcher & Monte-Colombo, 2010; Gelen, 2010; Needman et al., 2009;

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Vasileiou, Michailidis, Gourtsoulis, Kyranoudis και Zakas, 2013;Winchester et al., 2008; Famisis, 2015; Galazoulas,2017). However, the majority of these researches, examined the effect of static and dynamic stretching protocols, in which no kinetic activity is incorporated after static or dynamic elongation of the muscles in the participants. In soccer, however , after muscle elongation follows the specific part of the warm-up , dominated by high intensity dynamic competitive motor actions similar to those of the game

The effect of dynamic motor activities to power efforts after static or dynamic stretching was examined by some researchers with contradictory results (Young & Behm,2003; Little & Williams,2006; Pearce at al., 2011; Turki, Chaouachi, Behm, Chtara, Chtara, Bishop, Chamari, and Amri, 2012; Taylor, Sheppard, Lee & Plummer, 2009; Papadopoulos et al,2015). Young & Behm (2003) indicate a reversal of the negative effects on strength and power activities resulting from the execution of static stretching when post-implementation activities performed with dynamic way. Similar results on sprint and vertical jump found by Taylor et al (2009) in netball athletes and by Papadopoulos et al (2015) in female soccer players on the sprint, where after applying static stretching, a specific warm-up followed up with motor actions of the sport. Pearce et al (2011) , found a deterioration of the vertical jump following the application of static stretching and improvement tendencies after performing the various dynamic actions. They, also, found improvements in the vertical jump following the application of dynamic stretches and further improvement after performing the various dynamic actions.. Little & Williams (2006) found improvements in sprint to professional footballers with the application of specialized warm-up after performing static and dynamic stretching of lower extremities muscles, while Turki et al (2012) found improvement in sprint to soccer and handball players after applying short-term dynamic efforts (1 and 2 sets of 14 repetitions) and worsening of sprint when the duration was longer (3 sets of 14 repetitions) followed by 5 minutes special warm-up, that included progressive intensity sprints.

Considering that most researches do not take into account the warm-up structure and because the sprint is considered to be an important element of to soccer players performance during the match, with surveys reporting contradictory results after the application of static and dynamic stretching, it would be useful to investigate the role of specific phase of the warm-up on sprint performance in specific soccer conditions. The purpose of this study was to examine the effect of specific warm-up on sprint after the application of static and dynamic stretching in realistic competitive conditions in amateur soccer players.

Materials and methods

Participants

Sixteen (16) volunteers amateur soccer players, aged 21,41±3,28 years old, height 176±0,40 cm and weight 71,44±6,08 kg, participated in the research. The participants had no muscular problems and injuries in the last 3 months, before conducting the research. The study was held according with the principles of the Code of Ethics for Research of the Aristotle University of Thessaloniki., Greece.

Protocol Process

All the players performed two different stretching protocols individually in different days, one week apart. The first protocol included a) 8 min general warm-up, b) 20m sprint test (first measurement), c) 6 min of static stretching, d) 20m sprint test (second measurement) , e) 13 min specific warm-up and f) 20m sprint test (final measurement). The second protocol was similar to the first except the fact that static stretching was replaced by the dynamic ones. The participants were not allowed to do any activities during the day of the measurements and a day before. For the more effective control of the protocols, another four (4) additional players participated in the study, who helped only to perform the cooperative exercises and were not included in the study when collecting the data. Both protocols applied in the same time of the day and on a field with natural turf, while familiarization with the protocols took place on a separate day from the days of the measurements.

The general warm-up included low intensity aerobic running and lower limb kinetic actions including jogging, skipping, kicking, side steps, cross-steps, zig-zag movements towards and backwards and 2 submaximal sprints, preparing the soccer players to measure the first sprint (starting sprint). Static and dynamic stretching were triggered the same muscle groups (hamstrings, quadriceps femoris , adductors, hip flexors, gluteus and gastrocnemius). Each static stretching was held for 10 sec , alternately on each limb and repeated twice (2X10 sec) for each muscle group, without rest between repetitions. All stretching exercises performed in the full kinematic range of motion (ROM) of the joints without pain. Each dynamic stretching exercise performed for 10 sec alternately and repeated twice (2X10 sec) for each limb , with no interruption , except the dynamic exercise for the quadriceps where the heeling lasted 20 sec (10 sec for each limb) and repeated for other 20 sec after a 10 sec rest. Also, the dynamic exercise for the gastrocnemius was carried out at the same time for both limbs for 10 sec and repeated one more time after a 10 sec rest. The static and dynamic stretching exercises executed based on the protocol of a previous study (Vasileiou et al. (2013)).

Specific warm-up

The specific warm-up was executed 1 min after the end of the static or dynamic exercises with higher intensity and alternating rate including movements that resembled those in the game. The content of the specific warm-up included a) dynamic movements that activate the lower extremities muscles and were performed rhythmically for 15 m alternately at both legs, b) 5v5 small sided game, 2 min duration in a 40X30m. field area, c) 3 min tactical exercise in high intensity , d) 2X10 m. sprint in a straight line with 30 sec break between the repetitions, e) 2X10 m. sprint with changes of direction with the same break as above. Between the different exercises and games mediated always 1 min active recovery break, that included walking and respiratory exercises without static or dynamic stretching.

Sprint measurement

For the sprint measurement used the 20m. sprint test. Each participant performed one maximal effort of each test. Photocells Newtest Powertimer 300, (PC Upgrade Kit, FIN 90220 Oulu, Finland) were used for the sprint measurements. The test process and the use of the photocells was the same with a previous study (Galazoulas,2017).

Statistical analysis

The one way repeated measures analyses of variance was used for the statistical analysis. All the significantly different values were checked by the Bonferroni post hoc analysis. The significant level of $p<0.05$ was selected.

Results

By the simple method of correlation analysis with repeated measures (one way ANOVA repeated measures), a significant effect of sprint time ($F_{2.30} = 6.022$, $P <0.006$) was observed in the three states examined in the static stretch protocol (Figure 1), showing that static stretching, as well as the specific warm-up that follows, affect positively or negatively the sprint performance. According to the Bonferroni test, sprint performance deteriorated after the application of static stretching (time 2, $p <0.05$) and improved after the specific warm-up (time 3, $p <0.005$). No differences in performance were observed between the initial time sprint performed before static stretching and the final time sprint after the specific warm-up.

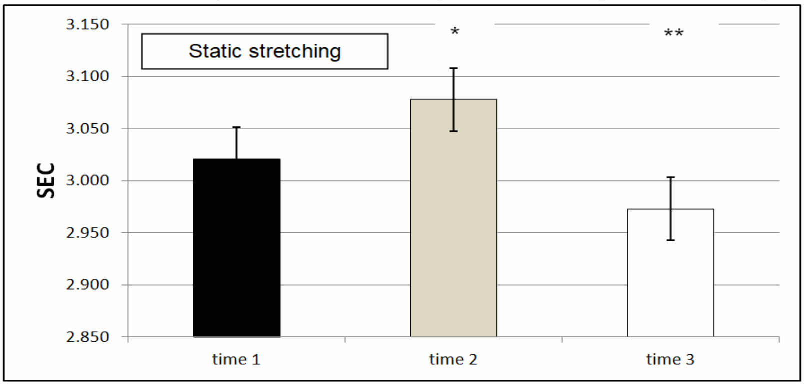

Fig. 1. Sprint 20m. Amateur Soccer Players, Before (Time 1), After The Static Stretching (Time 2) and immediately after the specific warm-up (time 3) (**$p<0.01$, *$p<0.05$))

No effect of sprint time ($F_{2.30} = 1.274$, $P> 0.05$) was observed in all three states examined in the dynamic stretch protocol (Figure 2), indicating that dynamic stretching as well as the specific warm-up that follows do not affect positively or negatively sprint performance.

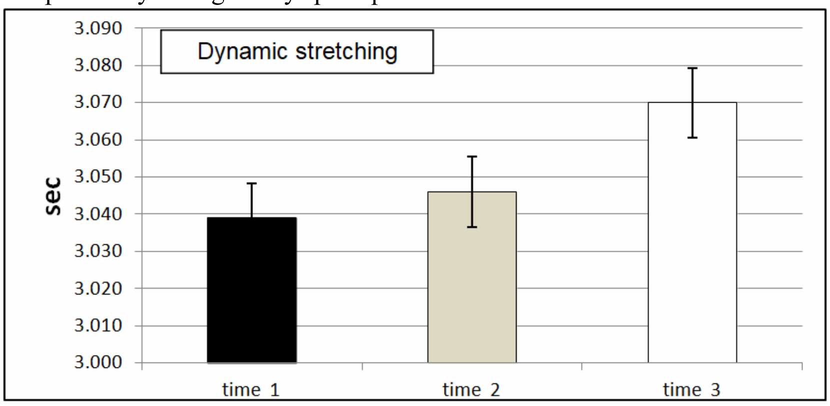

Fig.2. Sprint 20m. Amateur Soccer Players, Before (Time 1), After The Dynamic Stretching (Time 2) and immediately after the specific warm-up (time 3)

Discussion

In the present study was examined the effect of specific warm-up on 20m. sprint performance in amateur soccer players in realistic competitive conditions in the field after the application of static and dynamic stretching, while the literature examines the acute effect of static or dynamic stretching in laboratory condition, without taking into account the real structure of warm-up before the game, where the sports specific warm-up with specific soccer actions follows the stretching phase.

The results of the survey showed deterioration of the sprint time after the application of static stretching and no change after the dynamic stretching. Alongside, it showed that the specific warm-up effects positively the sprint time, when it is executed immediately after the static stretching in contrast with the specific warm-up that it is not affect neither positively nor negatively the sprint time, when it is executed after the dynamic stretching exercises.

The results of the present study on worsening of sprint immediately after static stretching agree with corresponding researches that they show similar findings (Fletcher & Jones, 2004; Fletcher & Monte-Colombo, 2010; Gelen, 2010; Needman et al. 2009; Nelson et al. 2005; Sayers et al. 2008; Vasileiou et al., 2013; Winchester et al. 2008; Papadopoulos et al, 2015, Famisis , 2015; Galazoulas, 2017). Some mechanical and neurological factors are considered responsible for the deterioration of sprint time after the direct application of static stretching exercises (Sayers et al. 2008), such as the musculotendinous system stiffness (MTU) (Fletcher & Jones, 2004), the reduced muscle temperature (Pearce et al. 2011; Mohr, Krustrup, Nybo, Nielsen & Bangsbo 2004), the neural inhibition (Nelson et al. 2005) and the reduce of myoelectric potentiation (Sayers et al. 2008; Winchester et al. 2008), which may lead to a reduction of the motor units recruitment ability and consequently in the reduced power production (Bosco, Tarkka, & Komi, 1982).

Our findings, also, showed inversion and improvement of sprint time , when sport specific warm-up was applied after the static stretching. These findings are consistent with the results of other researches (Little & Williams 2006; Samson, Button, Chaouachi & Behm 2012; Taylor et al, 2009). This reversal may be due the increased muscle temperature. According to Bishop (2003), the extra time of warm-up can lead to an increase in muscle temperature and the speed of neural impulses, instead of the execution of static stretching that they reduce the heart rate (Fletcher & Monte-Colombo, 2010). This increase of body and muscle temperature due to increased heart rate seems to cause a decrease in muscle and joint resistance (Fletcher & Monte-Colombo, 2010) and at the same time a greater sensitivity of the nervous sensors , which may increase the rate of nerve impulses by increasing the muscle contraction, making it faster and more powerful (Shellock & Prentice, 1985). The above hypothesis is reinforced by the study of Pearce et al (2011), who recorded a lower heart rate (88,3±4,2 bpm) after static stretching and higher (121,4±1,85 bpm), after the specific warm-up. Similar increase in heart rate was also observed in the study of Fletcher & Monte-Colombo (2010). Although in the present study the muscle temperature was not measured, however, the sweating was observed in all players , indicating a rise in body and muscle temperature and explaining the inversions in the sprint.

The results of our study have also shown that the dynamic stretches interposed between the general and the specific part of the warm-up, do not affect the sprint neither positively nor negatively. The above findings are in contrast with the results of Fletcher & Jones (2004), Fletcher & Monte-Colombo (2010), Gelen (2010), Little & Williams (2006), Pearce et al. (2011), Vasileiou et al. (2013) and Galazoulas (2017), who report improvement in performance after the dynamic exercises. The different results may be due to the sample of participants but also to the different protocols applied . Moreover, the break between the dynamic exercises and the beginning of the tests, it is likely, to be another cause of different results. Despite the fact that no improvements were found on sprint after the dynamic stretches, however, there was no observed deterioration of the sprint , similar those after the application of the static stretching, which factor reinforces the view that dynamic type stretches is preferable to the static type warming up of athletes for power activities (Galazoulas, 2017).

This research also shows that the specific soccer warm-up does not affect positively or negatively the sprint after the dynamic stretches. These results contradict the findings other studies (Faigenbaum et al. 2006, Little & Williams, 2006, Pearce et al. 2011, Turki et al. 2012; Taylor et al, 2009). The specific warm-up ensures the activation or the recruitment of motor units required to achieve maximum neuromuscular performance (Young & Behm, 2002). Equally, dynamic stretches recruit motor units with a higher stimulation threshold than static stretching. Because the sample in the present study was amateur players and according to their statement they did not have previous experience in dynamic exercises, probably the motor units activated during the execution of the dynamic stretches, but ,also, the specific warm-up , they reached in a fatigue state quickly, resulting in this decrease in sprint performance. The factor of fatigue seems to be related to the warm-up intensity (Fradkin et al, 2010). In the study of Faigenbaum et al (2006) the sprint performance declined when participants performed dynamic stretches , wearing an external weight , in terms of the performance after the execution of the same dynamic exercises without the external load. Turki et al (2012) found deterioration of the sprint after 3 sets of dynamic exercises involving 14 repetitions per set in each exercise, as opposed to improvement of sprint after 1 and 2 sets , followed from 5 min specific warm-up included progressive intensity sprints. The proprioception and the followed contraction coordination observed by dynamic stretches due to the similarity they have with dynamic movements likes sprint (Fletcher & Jones, 2004) are likely to be covered by fatigue, due to higher intensity (Turki et al. 2012). All the participants , when they asked by the examiner , felt fatigue after the execution of dynamic exercises and it was more intense after the specific warm-up.

One of the factors that seems to affect positively the increase of performance in force activities after the dynamic stretches, is the post-activation potentiation (PAP) (Gelen, 2010; Needman et al. 2009). However, the high intensity load leads to fatigue (Faigenbaum et al. 2006), which coexists in muscle s with PAP (Docherty & Hodgson, 2007). The balance between fatigue and PAP in the recovery phase determines the level of performance (Turki et al. 2012). The PAP depends on the intensity and the volume of the previous load and the time recovery after it until the beginning of the activity (Faigenbaum et al. 2006, Xenofondos, Laparidis, Kyranoudis, Galazoulas, Bassa and Kotzamanidis (2010); Turki et al. 2012). In the present study the amount of specific warm-up was high and the intensity was high and the break was minimal, in contrast with the study of Turki et al (2012) , where the time between the end of the specific warm-up and the beginning of the sprint test was 5 min.

As mentioned before, the sample and the content of the protocol are factors that may affect the results between different studies (Pearce et al. 2011). In the present study the sample was low-level amateur soccer players who did not have experience and they were not trained in a dynamic type stretches. Contrary to the Turki et al (2012) study , the sample consisted of high level soccer and handball players, the sample of Little and Williams (2006) study consisted of professional soccer players , while the participants in Rearce et al (2011) and Samson et al (2012) studies were trained students. Moreover, the protocol of specific warm-up in the Little and Williams (2006) study included straight forward and changes of direction sprints for a total 4 minutes, while Turki et al (2012) applied progressively straight sprints increasing intensity for total of 5 minutes. In the literature, to our knowledge, are not mentioned studies that they applied specific warm-up with sport exercises , in contrast with the present study that it uses specific competitive warm-up with soccer exercises.

Our results show the necessity to investigate in the future the role of the similar specific warm-up in a high level or amateur soccer players in the training process with the dynamic type exercises in several weeks, which resembled specific warm-up, to clarify the role of the specific warm-up on sprint after dynamic stretches.

Conclusions

The results of the present study show that the specific warm-up in competitive conditions reserves the negative effects on the 20m. sprint after the application of static stretching and no affect positively or negatively this ability after dynamic stretches in low-level amateur soccer players. Moreover, they show that the soccer players can to incorporate in their training session and the game warm-up dynamic type exercises replacing static type stretches.

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