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ORIGINAL RESEARCH OPEN ACCESS

THE ACUTE EFFECT OF STATIC OR DYNAMIC STRETCHING EXERCISES ON SPEED AND FLEXIBILITY OF SOCCER PLAYERS

Vasileiou, N[1], Michailidis, Y[2], Gourtsoulis, S[1], Kyranoudis, A[1], & Zakas, A[1]

[1]*Department of Physical Education and Sport Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece*

[2]*Department of Physical Education and Sport Sciences, Democritus University of Thrace, Komotini, Greece*

ABSTRACT

Introduction: The main aim of the present study was to examine the acute effect of static and dynamic stretching during warm-up on running speed of amateur soccer players. A secondary aim was to determine the effect of stretching on the flexibility of the lower extremities. Methods: Twenty-two players participated in this study (age 21.9 ± 3.2 years, height 1.81 ± 0.07 m, weight 77.0 ± 7.9 kg). Participants performed two experimental protocols on two different days in random order. The first protocol consisted of 10 minutes jogging and 5 minutes static stretching, while the second protocol consisted of 10 minutes jogging and 5 minutes dynamic stretching. Stretches were held for 10 seconds and were repeated twice. The athletes performed the flexibility and running tests of 20 meters, before and after the stretching protocols. Results: Statistical analysis showed that the static stretching protocol significantly reduced the running speed capacity of soccer players ($p < 0.001$) and the dynamic stretching protocol significantly improves the running speed capacity of the soccer players ($p < 0.01$). On the other hand, both stretching protocols induced significant increases ($p < 0.001$) in the joint flexibility of lower extremities of soccer players. Conclusion: The findings show that running speed capacity and lower extremity flexibility is affected by the type of stretching that comes before.

Keywords: static stretching; dynamic flexibility; running speed; soccer

INTRODUCTION

Over the last several decades, researchers have investigated the relationship between the flexibility and stretching and which is the most appropriate method to improve flexibility (1, 2). The majority of findings agree that after systematic stretching programs the kinematic range of the targeted joints improve significantly. The most common methods for development of flexibility are static or passive method and the active or dynamic method of stretching.

Static stretching is typically performed with slow movements until the maximum length of muscles is reached or at the full range of motion (ROM) of the joint (3). In contrast, dynamic stretching includes classic gymnastic exercises, performed by an individual or along with practitioners, stretching through the full range of motion of joints. These movements can be done either slow rhythmically or repetitive dynamically (e.g., swinging, bouncing, etc.) (1).

Along with improved joint range of motion, stretching exercises can also improve motor coordination and muscle sensation (4). In untrained individuals a sufficient level of flexibility also contributes to healthy postural stability. An athlete's flexibility can also positively affect their performance of skilful movements and allows the application of forces to a greater kinetic range over longer periods of time (5). Furthermore, researchers have shown improving flexibility can help prevent muscle pain (6) as well as reduce the risk of musculoskeletal injuries (7, 8). While there have been contradictory findings suggesting that improving flexibility may not in fact contribute to the reduction of injuries (9).

Workouts specifically designed to improve flexibility can indirectly affect the abilities of fitness (e.g., strength, power, and speed). In endurance, flexibility allows the execution of movements, with minimal expenditure of energy and with maximum running economy (10). In muscular strength it contributes to the implementation of the maximum power capacity, a higher functional level, within the larger kinematic range of joint (3). Regarding the speed, the normal length of the hamstrings, allows greater stride length (11). In these previously cited studies systematic stretching programs were performed, but the acute effects of these stretching exercises on flexibility, speed, and power are not clearly defined.

Nelson and Kokkonen (12) found that after 20 min of ballistic stretching flexibility improved by 9 %. In a similar study where participants performed 270 seconds of static stretches, joint ROM increased by nearly 10 %. While Behm et al. (13), observed no significant differences in ROM after 135 sec (3 × 45 sec) of static stretching.

The effects of static stretches on power studied by Nelson et al. (14) found that power decreased (4 %). Reduced jumping ability and sprint performance after static stretching exercises has been reported by a number of studies (15, 16, 17). While in contrast, several studies found static and ballistic stretching exercises did not have significant effect on power ability (18, 19, 20).

There are a wide range of findings on the impact that stretching has on an athlete's functional speed. Siatras et al. (21) found that static and dynamic stretching exercises reduced athlete speed. These same findings were reported by Fletcher and Jones (22), accompanied by the observations of an increase in speed after dynamic exercises. In a later study Nelson et al. (23) found decreases in speed after stretching exercises. In contrast, Little and Williams (24) observed no significant negative effects of stretching exercises on intense movements.

The effect of dynamic stretching on performance illustrates less impairment. More specifically, these kinds of stretching exercises have been reported to enhance performance in power (25, 26, 27) and sprint time (28).

It is common for soccer players to perform a lot of intensive movements during gameplay. Also, before games they often prepare themselves using warm-up activities that include stretching exercises. All of the differences in scientific findings have created a training environment that lacks confidence, causing mixed training methods promoted by trainers for soccer player warm-ups. Furthermore, there is a lack of scientific evidence dedicated to the acute impacts of these stretching exercises, as previous studies have emphasized longer-term effects.

The purpose of this study is to investigate the acute effect of static and dynamic stretching exercises during warm-up on speed and flexibility of amateur soccer players.

METHODS

Participants

Twenty-two healthy, amateur, male soccer players (age 21.9 ± 3.2 years, height 1.81 ± 0.07 m, weight 77.0 ± 7.9 kg) volunteered to participate in the present study. All the participants were involved in organized soccer training for at least 7 years (4-5 practices weekly) before the study. All testing procedures and possible risks and discomforts were fully explained in detail to participants before the start of the study. Each volunteer signed and was given a copy of a written informed consent prior to participation in the study. All study procedures were reviewed and approved by the university's institutional review board and ethical committee.

Experimental Design

Participants each performed two experimental trials in a counterbalanced fashion: a) trial with static stretching exercises, and b) trial with dynamic stretching exercises. Each trial was performed 7 days apart from each other and in random order 10 days after the end of competitive season. Participants' detraining was prevented by having them participating in light soccer training sessions (3 in these 10 days) prior to the study. Each of the participants was asked to abstain from any non-study strenuous physical activity during their time in the study.

During their first visit participant measurements of body mass, height, and body composition were collected. Next, each participant performed flexibility measurements and were then asked to conduct general warm-up exercises for 10 minutes. Following the warm-up periods each participant's sprinting speed was measured. The players then performed prescribed stretching exercises followed by the second test measures of speed and flexibility.

Testing was performed during the same time for each trial to mitigate potential circadian variations. All of the collected measurements were conducted by the same experienced physician specialized in sports medicine.

Stretching Protocols

Stretching exercises in each of the two trials were performed for the same muscles (i.e., hip adductor, flexor, and extension muscles), and each participant was familiarized with the stretching exercises prior to activities during the study. During the stretching exercises, players were guided through activities and no reported feelings of pain were noted.

Static stretching exercises were performed twice each and for 10 sec each. Rest periods of 10 sec were used between each set. Dynamic stretching exercises performed alternately for the legs (Table 1). The players make 10 repetitions for each leg and repeated two times.

Assessment of Anthropometric Profile

Body mass was measured to the nearest 0.5 kg (Beam Balance 710, Seca, United Kingdom) while participants wore underclothes only. Standing height was measured to the nearest 0.5 cm (Stadiometer 208, Seca).

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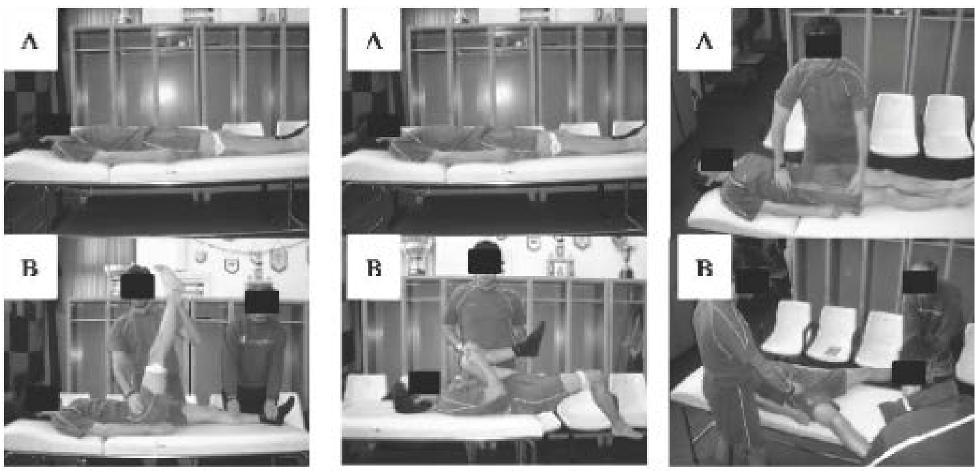
Table 1. –Static and dynamic stretching exercises.

Muscle	Static	Dynamic	
		Position	
		Start	End
Psoas-Iliacus muscles			
	One leg bent and placed forward (knee not extended past the ankle). Opposite leg extended backwards with the knee half and on the ground. The hip of rear leg pushed forward and both hands touching the ground.	Initially raising one foot with bent knee and then moving the leg behind with a fully extended knee.	
Hamstring muscles			
	Stretching one leg forward with the toes pointing up while bending the opposing leg. Reaching to touch forward knee with head.	Moving each leg front to back with knee extended.	
Leg adductor muscles			
	Siting on the floor, back straight, shoulders down, abs engaged, soles of the feet together to the front, and knees bent to the sides. Pull heels inwards to the body simultaneously pressing knees towards the floor.	Placing hands on a wall, dynamically adducting and abducting each leg.	
Quadriceps muscle			
	Lifting and bending at the knee, hold foot with parallel hand and pressing heel towards the buttocks while pushing the hip forward.	Flex at the knee joint so that the heels hit the buttocks.	
Calf muscles			
	Standing with legs parallel and both feet pointed forward, place hands on a wall keeping knees straight with the heels pressed to the floor.	Standing on the edge of a step. Point toes forward, letting both heels drop down.	

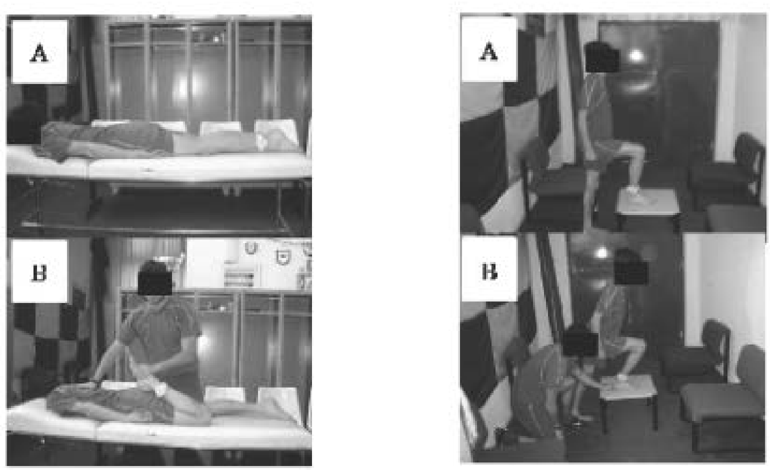
Flexibility Measurements

Flexion, extension and abduction range of motion (ROM) was measured for the hip joint. Flexion was measured for of the knee ankle joints. The ROM of the hip, knee, and ankle were each measured to the nearest 1° and was determined using Brodin and Myrin goniometers (Lic Rehab 17183 Solna, Sweden). Brodin goniometer was only used for hip abduction measurements. During flexibility measurements participants were wearing shorts, a t-shirt and were barefoot.

Using the Myrin goniometer: the instrument is fixed to the appropriate part of the using a Velcro fastening strap. The axis of the instrument is then placed as near as possible to the axis of the joint to be measured. This is made possible by the extension plate. For measuring around a vertical axis, the instrument is turned so that the compass needle pointed to zero. For measuring around the horizontal axis, the instrument is turned so that the inclination needle points to zero. The movement is then performed and the measure is read directly from the scale.



Hip flexion Hip extension Hip abduction



Knee flexion Ankle flexion

Figure 1. Flexibility measurements. A: Starting position. B: End position

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The Brodin goniometer is essentially a protractor with extending arms. The device fulcrum is aligned with the joint to be measured. Aligning the stationary arm of the device with the limb being measured, holding the arms of the goniometer in place while the joint is moved through its ROM. The degrees between the endpoints of the movement represent the entire ROM. All the measurements performed as described by Ekstrand et al. (29) and presented in Figure 1.

Speed measurements

A 20-m sprint test was used to measure speed performance. Using photocells (Photocell, TAG HEUER) placed 1.5 m above the ground (approximately shoulder height) and 20-m apart. Sprint testing was performed with the participants wearing soccer shoes on a field. The players begin one meter behind the first photocells gate and then ran 20-m passing the front of the second gate. The players sprinted two separate times, starting from a standing starting position. The fastest of these two sprints was recorded.

Statistical analysis

Data are presented as means ± SD. Data normality was verified with the 1-sample Kolmogorov-Smirnoff test; therefore, a non-parametric test was not necessary. Changes in dependent variables were examined with a 2-factor, repeated-measures ANOVA [trial (static and dynamic) × time (pre and post)]. When a significant effect was found, post hoc analysis was performed using a Bonferonni test. The level of significance was set at a = 0.05. SPSS version 16.0 was used for all analyses (SPSS Inc., Chicago, IL, USA).

RESULTS

Participants demonstrated comparable baseline values prior to each trial for all dependent variables examined. Speed reduced significantly after the static stretching exercises ($F_{1,21} = 27.792$, $p < 0.001$). In contrast the speed of the players increased after the warm up with the dynamic stretching exercises ($F_{1,21} = 11.850$, $p < 0.01$) (Figure 2).

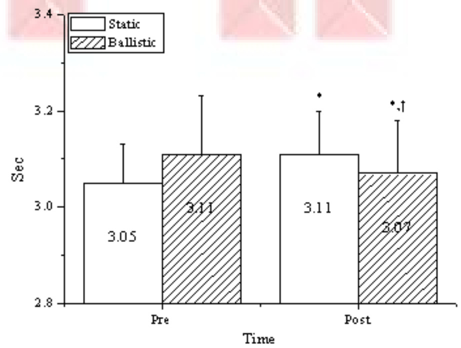

Figure 2. Speed changes after static and dynamic stretching exercises. Data are presented as mean ± SD; *, denotes significant difference with pre value ($p < 0.05$); †, denotes significant difference between trials (static – dynamic) ($p < 0.05$).

Joint flexibility improved after both types of stretching exercises. No differences found between trials (static or dynamic). Hip flexion improved significantly after static 4.3 % and dynamic 5.1 % stretching exercises ($F_{1,21} = 62.498$, $p < 0.001$) (Figure 3A). Hip extension increased 220 % after static exercises and 200 % after dynamic ($F_{1,21} = 69.588$, $p < 0.001$) (Figure 3B). Hip abduction increased for 12.3 % with static stretching exercises and for 14.3 % after dynamic exercises ($F_{1,21} = 68.303$, $p < 0.001$) (Figure 3C). Also knee flexion increased after static and dynamic stretching exercises (3.7 %, and 4.1 %) ($F_{1,21} = 50.336$, $p < 0.001$, respectively) (Figure 3D). Ankle flexion improved 11.4 % after static exercises and 13.2 % after dynamic exercises ($F_{1,21} = 39.328$, $p < 0.001$) (Figure 3E).

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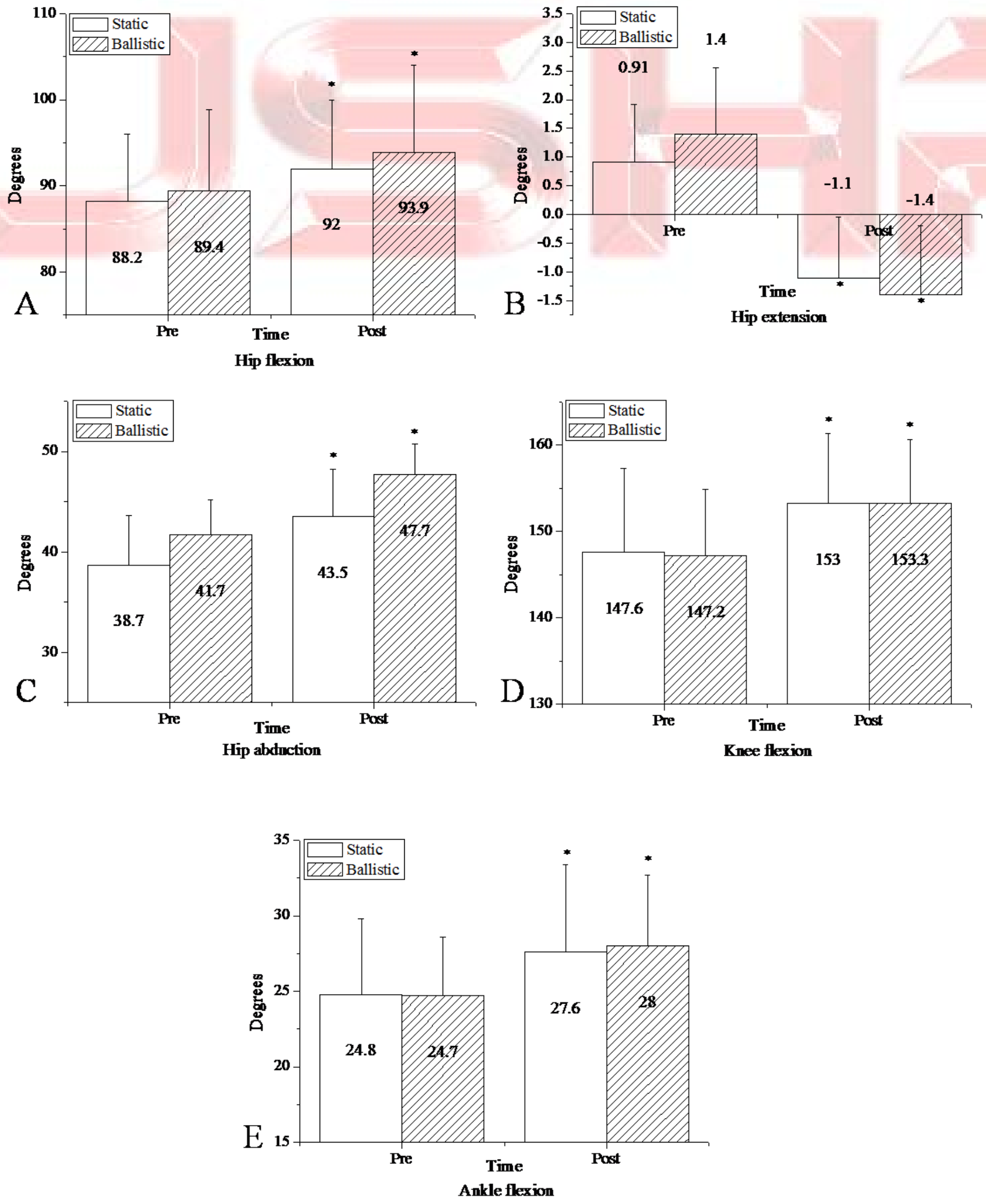

Figure 3. Flexibility changes on hip, knee and ankle after static and dynamic stretching exercises. Data are presented as mean ± SD; *, denotes significant difference with pre value ($p < 0.001$).

DISCUSSION

The present study investigated the acute effect of static and dynamic stretching exercises to sprinting speed of amateur soccer players. The results from this study showed that static exercises of 20 sec reduced an individual's sprinting speed. On the other hand the same duration of dynamic exercises increased the speed.

Within the literature there are several studies that have examined the effect of stretching on various types of strength (11, 12, 30, 31, 32), and jumping ability (14, 15, 33). In the past several years researchers have turned their interest to the effect of stretching on speed (21, 22, 23, 24), with contradictory results. As there are a multitude of studies all using varied methods, it is difficult to compare them. Therefore, only indirect comparisons of these different results have been used for this study.

The maximum running speed of players in this investigation decreased significantly when preceded by static stretching. This finding is in accordance with the findings of previous studies (21, 22, 23). The responsible mechanisms for the reduction of the speed after static stretching exercises are not clear. As possible explanations have been reported mechanical factors (34), such as the reduction of the hardness of musculotendinous system (35, 36). Wilson et al. (37) found a significant relationship between musculotendinous stiffness and power output. Another potential issue could be a reduction mechanism as a neuromuscular factor (32, 38). This factor focuses on the action of the tendon organs of Golgi, which are activated in cases of high strength, causing the autogenic inhibition. So, after that the specific muscles relaxed (39), with possible consequent reduction of maximum output power. A third possible factor of power reduction, after the static stretching, is partial muscle damage (40).

Another important note is the potential for prolonged static stretching, beyond 20% of the length of the muscle fibers, in causing loss of contractile elements of the muscle, as evidenced by increased creatine kinase detected in the blood (41). However, these mechanisms have not been fully elucidated (42).

In contrast with the above studies Little and Williams (24), observed increases of speed after static stretching exercises. These researchers have examined the effect of three different warm-up programs in four consecutive physical conditioning tests, which took place in 14 minutes. The speed test was the third of the total four tests and they used running starting position.

On the other hand, dynamic stretching exercises do not appear to reduce muscle performance, particularly in the running speed. On the contrary, they appear to have a favorable effect. The results of our study agree with those of Fletcher and Jones (22). The performance of the athletes sprint depends on many factors, such as their power, the speed of muscle contraction, their psychological condition and their running economy (40).

One possible reason for positive effect of dynamic stretching exercises may be the largest increase of body temperature (compared with static stretching exercises) (24). The increase of body temperature causes an increase in the sensitivity of nerve receptors and an increase in the speed of passage of nerve impulses that cause muscle contractions (8). Static stretching is believed to create alterations in musculotendinous stiffness (38, 43) or decrease reflex sensitivity (44) and therefore decrease the transmission of forces which are essential variables to power movements.

Siatras et al. (21) found no significant differences in speed of young gymnasts, after sixty seconds of dynamic stretching. These researchers reported neurological mechanisms responsible for these findings, as the action of myotatik reflex that causes spontaneous inhibition. Some studies (45) indicated that the myotatik reflex is associated with the speed of stretching and that it has an effect on hardness of musculotendinous (46).

It should also be mentioned that dynamic stretching exercises are more specific to the movements made during the sprint, in comparison with the static stretching exercises (22). In our study the dynamic exercises were more closely resemble the movements performed during the running speed.

In the present study static stretching protocol significantly reduced the running speed capacity of amateur soccer players while dynamic stretching protocol significantly improves the running speed of the players. On the other hand, both stretching protocols induced significant increases in the joint flexibility of lower extremities of soccer players. Our results are in consensus with these investigations using stretching programs (47, 48).

Athletes should be cautious when they use static stretching before an event that requires high-speed performances. The margin between the winning and losing in soccer is small and may be the kind of the warm-up that can do the difference.

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