Foam rolling compared to dynamic stretch and 20 meter sprint time performance

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Abstract

Background: Foam rolling (FR) is, compared to dynamic stretch (DS), a relatively new method used in warm-up routines prior athletic performances in for example, sprinting and soccer. The research on the subject is limited and further investigation is needed to better understand about the possible effects of foam rolling on performance. By comparing FR to DS this study focused on how foam rolling may affect sprint time on 20 meter.

Aim: The aim of this study was to compare FR to DS included in warm-up routines prior 20 meter sprint performance. The study was done on young male soccer players.

Method: Fifteen subjects participated in the study aged 16-17 years. A randomized cross over design was used over two test sessions with one week apart. Half group began with FR included in the warm-up routine and half began with DS included in the routine. The fastest sprint times in 20 meter were analyzed in a dependent t-test to investigate possible different effects between the two warm-up routines.

Results: The result showed no statistical significant difference between the two warm-up routines on sprint time (p=0.54). Mean sprint time was 3.05 for FR and 3.05 for DS. Standard deviation (SD) was 0.14 for FR and 0.16 for DS.

Conclusion: This study showed no difference on 20 meter sprinting performance when FR was compared to DS. That indicates that FR as well as DS can be included in warm-up routine prior short sprints without differences in performance. However, studies with larger sample size are needed to investigate the possible affects of foam rolling on physical impact and sprint performance.
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Introduction

Foam rolling as self-myofascial release is a relatively new method used for recovery, rehabilitation and warm-up. Lately more research has investigated foam rolling and its effect on different performances for example, vertical jumps, agility and isometric strength (Healey, Hatfield, Blanpied, Dorfman, & Riebe, 2013). Foam rolling is now widely used by athletes as an alternative in warm-up routines prior for example, soccer and gym training. Foam rolling and dynamic stretch has rarely been compared as warm-up routines to sprinting. Dynamic stretch is widely used in warm-up routines prior sprinting and soccer and is therefore relevant as comparison (Behm & Chaouachi, 2011). The existing research on foam rolling is limited and therefore more studies are needed to establish foam rolling’s effect on performance. Present study investigated possible differences in performance between foam rolling and dynamic stretch included in warm-up routines prior 20 meter sprinting.

Background

A warm-up routine is an important and critical phase before performing physical activities. The routine often includes several different physical exercises. To meet the demand of a certain activity the warm-up routine need to be adapted. For example, in sprinting performance warm-up exercises that include lower extremities are preferable. The main task of the warm-up routine is to prepare the body for physical activity by warming the muscles and body and increase mobility without a negative affect on performance (Fradkin, Zazryn, & Smoliga, 2010).

Soccer demands ability to create high sprinting skills for the athletes. That means acceleration capacity and ability to run at top speed on short distances mostly from 5 to 30 meters. The mean sprinting distance in field based team sports including soccer is 20 meters (Turki et al., 2012; Sim, Dawson, Guelfi, Wallman, & Young, 2009). To achieve good capability for sprinting the warm-up routine is an essential part. An improper warm-
up routine could have a negative impact on performance (Fradkin et al., 2010). For example, a too long warm-up can have a fatiguing affect (Turki et al., 2012) and certain stretches may decrease contraction ability of the muscle and lower the speed performance (Alikhajeha, Rahimi, Fazeli, & Fazeli, 2012). Several various warm-up routines are recommended for sprinting and athletes use both dynamic stretch (DS) and foam rolling (FR).

**Sprint**

Sprinting is running at high speed in short durations. In short distance sprinting it is important that the body and muscles produce horizontal force and velocity (Wiemann & Tidow, 1995). The ability to run fast is depending on stride frequency and stride length. At the start of a sprint acceleration is important. Acceleration is depending on the ability to create power (force x velocity). To get speed in sprinting stretch shortening cycle is important as sprint consists rapid movements that use release of stored elastic energy and stretch reflex in the muscles and tendons (McArdle, Katch, & Katch, 2010). Hip flexion and knee extension are the movements of the early flight phase. At the middle of flight phase the knee extension change to knee flexion and in the end of flight phase the hip flexion change to extension. In the early support phase the hip extension continues and the knee flexion change to a minimized extension that become a limited flexion while the foot strikes the ground. Eccentric plantar flexion also happens at foot strike. At late support phase the hip flexion decelerate and a rotation of the backward thigh happens to prepare for a forward movement (Baechle & Earle, 2008). Muscles that play the mainly roll in sprinting are hamstrings (semitendinosus, semimembranosus and biceps femoris), gluteus maximus and adductor magnus. Gluteus maximus is a great hip extensor but also does hip rotation and abduction. Adductor magnus play an important roll as synergist to gluteus maximus in sprint. Hamstrings are active the whole phase of the hip extension. Gluteus maximus is only active at the first half of the support stance and in the backswing. Adductor magnus is active in the first part of the support phase. Hamstring, adductor magnus and gluteus maximus working together provides the energy needed for forward propulsion (Wiemann et al., 1995).
Critical for achieving fast sprinting capabilities is the contractility and excitability of the neuromuscular system, the maximal cross bridge cycling rates and stretch shortening cycle. Right technique is also important for sprinting. Incorrect technique is a barrier that can be due to incorrect learning but also from limits in range of motion (ROM) that affect the mechanical movements (Baechle et al., 2008). In sprint hamstrings are under strain, which makes the flexibility and warm-up of the muscle important (Wiemann et al., 1995; Sun, Wei, Liu, Zhong, Fu, & Li, 2014).

Warm-up

Warm-up routines are used to get the body ready for physical activities. According to a meta-analysis of Fradkin et al. (2010) most kinds of physical performances are accomplished with better results after warming up. One result of warming up the muscles is increased blood flow. This may lead to improvement in performance explained by, faster muscle contraction, lower viscous resistance within active muscles, greater oxygen release from hemoglobin, facilitated nerve transmission and muscle metabolism and increased blood flow through active tissues. A warm muscle also reduce the risk of injuries in different tissues (McArdle, Katch, & Katch, 2010; Woods, Bishop, & Jones, 2007). Muscle strains or pulls are injuries that occur from forces within the muscles and they usually appear during physical activities (Woods et al., 2007). A proper warm-up lengthen the muscle tendon and allow the muscle to a greater stretch and more resistance to an external load (McArdle et al., 2010).

Warm-up routines prepares the performer both physically and mentally. According to Fradkin et al. (2010) a warm-up routine should start with a general aerobic activity followed by stretching and finish with an exercise similar to the one being performed. The general aerobic activity is to get the body and muscles warm. The stretching part is to minimize risk for injuries when performing movement with high intensity in ROM. The specific exercises in the end of the warm-up routine makes the athlete ready for the activity both mentally by leading the focus to the right movements and physically by
improving coordination, skills, accuracy and timing for the specific movements (Fradkin et al., 2010).

Several studies are done on different warm-up routines and their effect on various physical performances and flexibility. Sport-specific movements, static stretch (SS), massage, DS, and FR are examples of exercises included in warm-up routines (Fradkin et al., 2010). Different warm-up routines have also been evaluated against each other. One example is DS compared to SS that has often shown that SS affects the performance negatively (Alikhajeha et al., 2012).

Warm-up is a well-studied field but since new methods are developing, more research is needed. For example, compared to DS, FR is a relatively new technique that requires more studies to confirm its effect as a warm-up. FR is hypothesized to have an effect on the fascia structure in the muscles and its pliability affecting the outcome of the procedure (MacDonald, Penney, Mullaley, Cuconato, Drake, Behm, Button, 2013).

**Fascia**

Fascia is a soft connective tissue that encircles muscles, bones, organs, and nerves in the body and works as support and stability. In muscles, fascia exists in layers, superficial fascia, deep fascia, and the third layer where fascia exists in and around the muscles in epimysium, perimysium, and endomysium. Superficial fascia contains fat and exists subcutaneous. It works as protection and contains blood vessels, nerves, and lymphatic vessels from and to epidermis. Deep fascia contains less fat and converges all muscles, organs, nerves, and glands. Fascia exists in epimysium that converges the muscles, perimysium that converges bundles of muscle fibers, and endomysium that converges every muscle fiber (Findley, Chaudhry, Stecco, & Roman, 2012). Fascia consists of collagen that prevents stability and form and elastin that makes it dynamic and flexible. As fascia serves as a barrier to blood vessels and nerves, it affects important bodily functions for example, nutrition flow, body temperature, and nerve signals (Barnes, 1997).
Fascia has an important role as a transmitter of mechanical forces between muscles and bone (Findley et al., 2012). The fascia within and around the muscle converges close to the end of the muscle and forms a tendon where force from muscle contraction is transmitted to the bone (Baechle & Earle, 2008).

Training often results in adaptation of the fascia to manage the increased load. It responds from increased muscle strength, hypertrophy and strain on the muscle. Areas that can adapt to greater strength load-bearing capacity are junctions between the tendon and bone surface, within the tendon and in the fascia surrounding the muscle (Baechle et al., 2008).

When fascia is shortened it loses its pliability. The condition can be due to trauma, inflammation, long term static posture positions and even short term processes. Pain can be felt from pressure on blood vessels and nerves (Findley et al., 2012). Due to the fascial continuity in the body it has been shown that restriction in one part of the fascia may affect other parts that are surrounded by fascia (Ajimsha, Al-Mudahka, & Al-Mudahka, 2014; Barnes, 1997). Restriction in fascia surrounding muscles may affect the alignment of the body, coordination mobility and contraction possibility, ROM and reduce strength (Barnes, 1997).

**Myofascial release**

Myofascial release (MFR) is used to treat various kinds of conditions often by a physiotherapist or masseuse (Ajimsha et al., 2014). Several techniques can be used for MFR for example, stretch, pressure, massage, heat or friction. MFR is often used as hands on methods to decrease restrictions and tightness of the fascia structure. The hypothesis is that these techniques restore muscle length and improve function and the body alignment. It relieves pressure to blood vessels, nerves and decrease pain. A constant pressure is applied on soft tissue to create a stretch in the fascia (Barnes, 1997). MFR may release pressure that relieve the pain and reset blood circulation back to previous (Barnes, 1997; Findley et al., 2012). MFR performed correctly may lead to immediate pain relief and tenderness of the tissue (Ajimsha et al., 2014).
Self-myofascial release

Self-myofascial release (SMR) works the same principles as MFR without needing a second person. SMR is performed both as a rehabilitation and recovery method after training and as prehabilitation to physical activities (Peacock, Krein, Silver, Sanders, & Von Carlowitz, 2014). SMR can be performed by applying pressure to the connective tissue in different ways, for example tennis balls, rubber bands, and foam rollers in different sizes and shapes. FR is one method to perform SMR where using a roller to apply pressure on muscles of the body (Ajimsha et al., 2014).

Foam rolling

There are some hypotheses of the physical affects of FR. MacDonald et al. (2013) describes that when using a foam roller the fascia warms up and attends to become less viscous and restores extensibility. Other beliefs in function of FR are positive effects on muscular imbalance and soreness, improvements of neuromuscular efficiency, ROM and relief of joint stress. However, the studies are limited and need more research (MacDonald et al., 2013). According to Okamoto, Masuhara, & Ikuta (2014) SMR performed with FR also has a beneficial effect on arterial function. One bout of FR may reduce arterial stiffness and increase plasma nitric oxide that leads to a greater blood flow.

Some research has been done on FR as parts of warm-up routines. One study showed that FR had a positive effect on ROM and did not have any negative impact on muscle force or activation in quadriceps femoris. ROM was measured before FR, and two and ten minutes after and a difference of 8-10 % was shown. Force, muscle activation and ROM were measured before and after FR (MacDonald et al., 2013). When FR was compared to planking as warm-up the results showed no difference between the two on vertical jump, isometric force or agility. On measurements of fatigue there was a difference where less fatigue was shown when FR was used as a warm up (Healey et al., 2013). Peacock et al. (2014) compared two different forms of FR. Mediolateral that included erector spinae,
gluteus maximus, hamstrings, gastrocnemius, soleus, pectoralis major, minor, quadriceps and anterioposterial that included latissimus dorsi, sartorius, gluteus medius, tensor fascia latae, lateral calf region and adductores. The rutine included 30 seconds on each area with five rolls. There were no significant difference between the two in performance of broad jump, shuttle run and bench press. Halperin, Aboodarda, Button, Andersen, & Behm (2014) studied the affect of FR on calf muscles compared to SS. The study showed that both FR and SS increased ROM in plantar and dorsiflexion. Force production was relatively higher after FR compared to SS in one and ten minutes after.

**Stretch**

Stretching before vigorous physical performance can prevent injuries and is often recommended as a part of the warm-up. Soft tissues and muscles are elongated when stretching and can allow athletes to work in a wider ROM that otherwise would result in risk of injury. The performance after stretching can be affected depending on the method used (Woods et al., 2007).

**Static vs. Dynamic stretch**

It is well known that SS before physical performance that requires high force and power output may affect the execution negatively. Therefore it is not recommended as a part of warm-up (Alikhajeha et al., 2012; Arabaci, 2008). SS may have an adverse effect on performance in sprint, reaction time and vertical jump height (Arabaci, 2008).

Compared to SS, DS is more efficient for an increase in ROM without a significant effect on performance. When SS and DS were compared as warm-up routines to 20 meter sprint there were significant differences in performance where DS has an advantage (Alikhajeha et al., 2012). Some studies have shown similar results in flexibility in SS versus DS and since DS shows better results in performance that is a reason DS is chosen prior SS (Behm et al., 2011). Physical explanation to decrease in performance after SS may be neuromuscular decreased blood flow to the muscle during the stretch (Behm et al., 2011).
**Dynamic stretch**

DS is recommended before vigorous physical activities (National Strength and Conditioning Association, 2008). DS is controlled sport specific movements to prepare the body for physical activities. It is mostly including multiple joints and lets the muscle stay active during ROM. This is beneficial to keep the temperature in the muscles through the warm-up (National Strength and Conditioning Association, 2008).

The degree of stretching needed depends on which the following activity is. For example, sport including sprinting performance with a high demand on stretch shortening cycle needs a higher degree of stretching compared to cycling (National Strength and Conditioning Association, 2008). Turki et al, (2012) investigated dynamic stretch before short sprinting performance. The stretches included muscles of the lower extremities that are involved in sprinting, gluteus maximus, hamstrings, quadriceps femoris, adductors and soleus surae. The study recommended including up to two sets of DS per muscle group with 14 repetitions of each performed while walking approximately 20 meter. The activity should be performed within five minutes after completing the warm-up. Even more sets of DS may fatigue the muscles and affect the performance adversely (Turki et al., 2012).

Physical improvements that may occur from DS and be beneficial for performance are raised muscle temperature, increased ROM, post activation potentiation (PAP), improved neuromuscular function, increased force output due to a higher number of cross-bridges and inhibition of the antagonist muscle (Behm et al., 2011). PAP can be explained by a higher force production due to a previous contraction (Lorenz, 2011).

FR and DS are both possible ways to get a warm-up that increases the ROM without a significant decrease in performance. Due to limited research of FR and SMR and a greater use of FR among athletes there is a need of more investigations on the subject. This study is focusing on FR and its affect on 20 meter sprint time on young male soccer players.
Aim

The aim of this study was to compare self-myofascial release performed with foam roller to dynamic stretching included in warm-up routines on performance in 20 meter sprint time on young male soccer players.

Hypothesis

Based on previous research the hypothesis was that there would be no significant difference between the two warm-up routines on 20 meter sprint performance.
Method

Subjects

Soccer players from local teams were asked to participate in the study why trainers from different soccer teams were contacted. Fifteen healthy young male soccer players, age 16-17, from one team agreed to participate in the study. Inclusion criteria were one year experience of playing in order to have sprinting experience. Subjects with injuries that could affect the trials could not participate. The subjects were informed not to do any heavy training during the 24 hours before the tests.

Testing procedures

Five days before the first test session the subjects participated in a familiarization trial they learned all routines included in the study. The study was a cross sectional study with two test sessions with one week apart. The subjects performed one warm-up routine prior 20 meter sprinting in each test session. One time DS was included in the routine and one time FR was included. Each test was performed at the same time on the day in the same testing area. To get a balanced study the order in which the sessions were performed were randomized. At the familiarization trial each person draw a ticket that said if they would start with FR or DS.

Warm-up routines

The subjects started with a general warm-up exercise of five minutes of jogging around the hall in their own tempo. After jogging, half group did the DS routine and the other half did the FR routine. The warm-up routine ended with a sport specific part with two sprints in perceived 75 % of maximum speed with walking back as recovery (Fradkin et al., 2010). Two supervisors, one for DS and one for FR, gave instructions and made sure right technique and time was held.
**Dynamic stretch routine**

The stretches were performed when walking over 20 meters and the result was approximately 14 repetitions of each exercise (Turki et al., 2012). One stretch was performed for each muscle in two sets. Focus was on hamstrings, gluteus maximus, adductors, quadriceps femoris and triceps surae (Appendix 3). This part of the warm up routine took five minutes.

**Foam rolling routine**

The subjects were instructed to use the foam roller on following muscles, hamstrings, gluteus maximus, adductors, quadriceps femoris and triceps surae (Appendix 2). The FR procedure went from the origin of the muscle to the insertion with a constant speed and pressure. The subjects were informed to use their bodyweight to create pressure. When reaching the end of the muscle the direction should change immediately. The FR was performed unilateral on both legs on each predetermined area and the instruction was to do five rolls in 30 seconds (Peacock et al., 2014). This part of the warm-up routine took five minutes.

**Specific warm up**

At the end of the warm-up the subjects completed a specific part with two, 20 meter sprints at 75 % of maximum speed from their own estimation with walking back recovery and no rest between (Fradkin et al., 2010).

**Sprint procedure**

When finishing the warm-up routines the participants completed three final sprints from which data was collected. Sprinting equipment used was Timing gates (Musclelab, Ergotest, Norway). Two photocells were placed at start position and two at finish line at 20 meter. The subjects started the sprint with their optional front foot on a mark sat one
meter from the start line. They chose which foot to place forward with the instruction to use the same foot in each trial. They started on their own signal and were informed to run as fast as possible past the finish line. All test persons performed 20 meter sprint three times with two minutes rest between each set. The fastest time were collected for analyze. Between the sprints they walked back and waited for the next sprint (Turki et al., 2012). No verbal encouragements were given during the sprints.

**Ethical and social considerations**

All participants were informed verbally and in writing about the research and signed an informed consent (appendix 1) at the familiarization trial. They participated voluntarily and had the opportunity to leave the study without giving any reason. All personal information was collected and kept confidential. According to Swedish law (Lag om etikprövning som avser människor, 2003:460) no research should be made without giving information to and receive an agreement from each participant. All of the participants were aged under 18 years and therefore the informed consent were signed by them self and by a parent.

Research in general is important to the society and peoples development. This study will develop the knowledge about the effects of SMR performed with FR compared to Ds. It may help physiotherapists and different kind of trainers knowledge of how and what to use this type of warm-up routines for and provide the information.

**Statistical analyze**

Shapiro-Wilks test was performed to study data distribution and showed that the data was normally distributed (p>0.05). Differences between the two sprint tests, following either FR or DS, were analyzed with a dependent T-test. The data was analyzed in SPSS v.20.0 (SPSS Inc., Chicago, IL, USA).
Results

Fifteen subjects completed the two trials and are included in the statistical analyze of the results. The subject characteristics age, height and weight, 16-17 years, 165-190 cm and 55-75 kg are shown in Table 1.

Table 1. Subject characteristics (n = 15)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>16.2 ± 0.9</td>
</tr>
<tr>
<td>Height, cm</td>
<td>177.8 ± 6.8</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>66.6 ± 4.8</td>
</tr>
</tbody>
</table>

No statistical significant difference was found between the sprint tests following either FR or DS as a routine (p = 0.56) (Table 2). Mean sprint time was 3.05 for FR and 3.05 for DS. Standard deviation (DS) was 0.14 for FR and 0.16 for DS (Table 2 and figure 1).

Table 2. Comparison of means in sprint times (dependent t-test) after foam rolling (FR) warm-up routine and dynamic stretch (DS) warm-up routine (n = 15).

<table>
<thead>
<tr>
<th>Sprint</th>
<th>Minimum (sec)</th>
<th>Maximum (sec)</th>
<th>Mean (sec)</th>
<th>SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprint FR</td>
<td>2.82</td>
<td>3.30</td>
<td>3.05</td>
<td>0.14</td>
<td>0.56</td>
</tr>
<tr>
<td>Sprint DS</td>
<td>2.80</td>
<td>3.39</td>
<td>3.05</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Mean sprint times and standard deviation (sec) of foam rolling (FR) warm-up routine and dynamic stretch (DS) warm-up routine (n = 15).
Discussion

FR is, compared to DS, a relatively new method used by athletes as parts of warm-up routines. The purpose of this study was to compare FR to DS, included in warm-up routines, on sprint performance in 20 meter. The result showed no statistical significant difference ($p = 0.56$) between sprint performances and indicates that either FR or DS could be included in warm-up routines without affecting performance in 20 meter sprint.

Results discussion

In this study FR was compared to DS included in warm-up routines prior sprint performance in 20 meter. Other studies have included FR in warm-up routines prior performance in for example agility, vertical jump and static strength, and found similarities. Healey et al. (2013) researched the possible affect of FR enhancing performance. Due to the similarities in performance between FR and planking, planking was used as comparing warm-up routine. Similar to present study FR was performed for 30 seconds on each muscle group focusing on the lower extremities and back. The results showed no difference in performance in isometric force, agility or vertical jump. This indicates that the performance did not differ in FR compared to planking but also that the performance was not enhanced from FR compared to planking. MacDonald et al. (2013) investigated a longer FR routine with two bouts of one minute performed on quadriceps femoris and compared to a control group. Also in this study no differences were shown on muscle force, rate of force development or muscle activation between the two warm-up routines.

SS is an exercise that is known to affect performance negatively (Alikhajeha et al., 2012). The mechanical movements are not effected by SS, which suggests that it is the neural capacity that is affected. SS affects SSC by a slower elastic return from the eccentric phase (Behm et al., 2011). Since FR showed no difference compared to DS that indicates that mentioned physical impacts is not affected negatively from FR. Halperin et al. (2014) compared SS to FR on calf muscles. Similar affect on increased ROM between SS and FR was found. Higher force production was showed one and ten minutes after FR
compared to SS. FR and SS was performed for three bouts of 30 seconds with ten minutes rest between each. The pressure was standardized by a scale of perceived pain rating from 0 to 10 were the subjects were asked to apply pressure to a pain level of 7 to 10 to induce maximal discomfort. Since SS is known to decrease performance (Behm et al., 2011) the present study was an interesting complement to this research. The present study may increase the credibility of this study and the hypothesis that FR does not have a negative effect on performance. The study can also be compared to other studies done on SS compared to DS where SS showed a negative effect on performance. No other studies known have compared DS and FR on sprinting performance. This study showed that there is no difference in sprint performance between these particular warm-up routines.

Peacock et al. (2014) studied two different approaches of FR on the same activities. The study differs from others since it is comparing FR against itself by warming up different muscles of the whole body and compare the same exercises. The results showed no difference between performance in agility, vertical jump, broad jump, shuttle run or bench press but showed a difference in the sit and reach test where the anterio-posterial FR had improved ROM. The study imply that FR performed on different muscles prior the same exercises does not affect performance. And indicates that FR could be performed on preferred muscles in warm-up routines.

The methods in mentioned studies and the present substantially differs and could possibly have affected the results. Time of FR differs from 30 seconds for one, two or three bouts and two bouts of one minute. The intensity and muscles being massaged also differs and may affect the outcome. A standardized intensity is something that may be difficult to achieve in FR. Peacock et al. (2014), Healey et al. (2013) and MacDonald et al. (2013) instructed the subjects to apply their body weight on the foam roller to apply pressure. Peacock et al. (2014) and MacDonald et al. (2013) also standardize the FR routine by deciding a number of rolls during each bout. Halperin et al. (2014) used a perceived pain rating scale to achieve similar pressure for the subjects. The subjects were also instructed
to work on the muscles from different angles which differs from the other studies (Halperin et al., 2014). At last, type of fascia varies over the body and may therefore react different on different muscles (Barnes, 1997). Calf muscles, quadriceps, lower extremities and a whole body concept is covered in this studies and affect of FR on various muscles and fascia type may therefore affect the research results. Mentioned differences between research methods may affect the comparability between the studies. However, despite various methods the studies disclosed similar affects of FR on performance with different approaches and may strengthen the probability for each study. Present study contributes to the hypothesis that FR does not affect performance compared to DS. To cover a big area of functions for FR these studies are considered valuable and useful for future research.

Soccer contains a lot of short distance sprints (Turki et al., 2012) and therefore demands a great function of SSC and acceleration capacity. Acceleration demands a high force output and make it essential that the warm-up routine does not affect these demands negatively (McArdle et al., 2010). Studies describe some physiological affects that are similar for both DS and FR. FR may lead to enhanced neuromuscular functions, warm the muscle and fascia and increase ROM (MacDonald et al., 2013) as does DS (Behm et al., 2011). FR is also discussed to decrease fascia restriction that can reduce pressure on nerves and blood vessels, improve bodily alignments and movements (Barnes, 1997), and also, FR may increase nitric oxide and dilation of blood vessels (Okamoto et al., 2014). Further affects that may come from DS are PAP and increased number of cross bridges (Behm et al., 2011). To take in consideration is that these affects from both methods are not entirely secured and more research is needed to fully understand the physical effects and differences of FR and DS. The limited research makes it insecure to include or exclude any of these physical affects with certainty. There is a need to discuss whether FR should be used instead of DS or vice versa. Therefore, the requirement of more research of the physical affects on these subjects is essential.
This study was focused on the immediate affect in 20 meter sprint on soccer players and indicate that FR does not differ from DS in performance. In consideration of the physical demands of a soccer game or practice this study is limited as it only focus on the acute affect on short sprinting performance. A soccer game includes several sprints in different distances and durations and also a variation between aerobic running and anaerobic sprinting during 45 times two minutes. Therefore, it would be in interest to investigate how and if FR is affecting long-term physical performances for example, sprint velocity or strength in a soccer game.

**Method discussion**

Soccer players were chosen as participants to standardize sprinting habits. A randomized cross over design was used to avoid that the order of which the warm-up routines were performed should affect the result (Connelly, 2014). Eleven out of fifteen of the participants completed the familiarization trial. This probably did not affect the test substantially because of the relatively easy test procedure. However the possibility of an effect on the study can not be precluded. The low sample size may have limited this study since it may increase the risk of a type II error. However, Halperin et al. (2014) included 14 subjects in one study and found a statistical significant difference ($p = 0.04$) when FR was compared to SS in force production. The study was a cross over study.

The mean difference in sprint time between FR and DS were 0.03 seconds and there was a spread from 0 to 0.9 seconds. Alikhajeha et al. (2012) included 120 subjects in a study comparing SS against DS on 20 meter sprint performance. The mean difference between sprint times between pre and post stretch were -0.06 seconds in DS, 0.03 seconds in active SS and 0.05 seconds in passive DS and showed statistical significant differences. This indicates that small differences resembled this studies results can lead to a statistical significant difference in sprint time for 20 meters. Furthermore, there were a high amount of participants and the low sample size in this study may have affected the results.
Even though statistical significant differences is shown between SS and DS it can be discussed whether the differences are relevant for neglecting the method that shows lower results. In previous mentioned research the mean difference shown was −0.06 seconds which is a very short time spectra. It may be essential for sprinters in competitions but may not affect the outcome of a soccer game.

Twenty meter sprint distance was used since it represents the mean sprint distance in field-based team sports, for example in soccer (Turki et al., 2012; Sim et al., 2009). Twenty meter is often used as distance in studies (Turki et al., 2012; Sim et al., 2009; Alikhajeha et al., 2012). Since soccer players normally sprints short distances during training and games it was beneficial to minimize error sources in the study.

The layup of the warm-up routines was supported from Fradkin et al. (2010) that describes a warm up routine from a review of 32 articles about warm-ups effect on physical performance. According to Fradkin et al. (2010) a warm up should start with a general activity to get the body and muscle warm, then include a stretching part to increase ROM and end with a specific part to prepare the body and mind for the comming exercise. DS was chosen as comparison since it is a widely used and approved warm-up exercise (Behm et al., 2011). The DS routine was performed according to Turki et al. (2012) study of DS routines espescially for 10 and 20 meter sprint distance. The DS was focused on the lower extremities and muscles primary used in sprinting (hamstings, quadriceps, gluteus, adductores, triceps surae) and was copied from the former study to this. What could have been taken in consideration from the DS was that the soleus stretch was not acctually a dynamic stretch but an alternating contraction of the cough muscles. This could possible affect the validity of the DS. Since the stretch routine was copied from a previos study the author made the choice not to change the execution.

To standardize FR the routine focused on the same muscle groups as in the DS routine. To be able to compare FR to DS both routines lasted for five minutes. FR was standardized to 30 seconds per muscle with five rolls forward and back during this time to have the same kind of pressure on each muscle and to ensure the speed of the
movements (Peacock et al., 2014). Both FR and DS were superwised by a trainer to ensure time and correct performance.

The warm-up routine used in the present study was based on a review article of Fradkin et al. (2010) that describes that a warm-up routine should end with a sport specific exercise. You may consider the possibility that the two sprints that ended the warm-up routine could have affected the validity and reliability of the measurements on FR and DS. The layup of the warm-up routines in this study resembles routines used prior soccer training (Turki et al., 2012). Therefore, the method is considered applicable to reality and is a research of how FR included in a warm-up routine affects performance. However, the perceived 75 % of maximum speed may be difficult to standardize and may have affected the results. To minimize factors that could have affected the validity of the test the subjects were asked not to do any heavy training 24 hours before the test sessions.

Critical in a warm-up routine is the ability to apply an increased length of the muscle without decreasing performance. This study among others indicates that FR does not affect performance compared to other warm-up routines. Other studies have also showed an increase in muscle length after FR (Halperin et al., 2014; Healey et al., 2013; MacDonald et al., 2013; Peacock et al., 2014). Increased ROM is an important factor of most warm-up routines (Woods et al., 2007). The purpose of the present study was to investigate performance after different warm-up routines. Nevertheless, since ROM is an important variable of a warm-up routine the study would have been further interesting if ROM had been measured after FR and DS. For future studies there would also be interesting to include a control group to a resemble test to investigate the actual affect on performance for both routines.

**Conclusion**

This study showed no statistical significant difference in 20 meter sprint time when FR and DS was compared as parts of a warm-up routines. Existing studies are leaning
towards FR being an alternative part of warm-up routines prior physical exercises in for example, jumping, sprinting and agility. The hypotheses are improvement in ROM and no decrease in performance. The conclusion of this study and also based on other research would suggest that soccer players and other athletes may choose FR or DS as part of their warm-up routine with no difference in performance. Since FR has become widely used by athletes more studies are needed to confirm its affect on physical functions and performance.
References


Appendix 1: Informed consent
Informerat samtycke

Hej!


Foam rolling är ett sätt att bearbeta musklerna i en form av massage. Vid användning av foam rolling masseras fascian som omsluter musklerna och spänningar och stramhet i musklerna kan minska. Utförandet går till så att man placerar foam rollern vid början av en muskel och använder kroppsvikten för att skapa tyngd och sedan för kroppen över foam rollern i ett jämnt tempo fram och tillbaka över muskeln.

Syftet med testet är att jämföra två uppvärmningar. En som inkluderar foam rolling och en som inkluderar dynamisk stretch genom att mäta sprinttiden på 20 meter.

Förfrågan om deltagande

Du tillfrågas för att du är medlem i laget Astrio. För att delta i studien krävs att du är skadefri och utan andra åkommor som kan påverka testernas resultat. Exempelvis sjukdom eller dylikt.

Tillvägagångsätt

Ditt deltagande i studien medför inga risker som inte förekommer under dina vanliga träningspass.

**Frivilligt deltagande**

Du som testperson har rätt att avbryta testet när som helst utan att ange orsak. Om så önskas kommer då redan insamlad data att förstöras.

**Sekretess**


Vänligen,
Frida Linderoth

**Ansvariga**

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Samtycke till deltagande i forskningsstudie

Nedan ger du ditt samtycke att delta i den studien som utvärderar den akuta effekten av foam rolling på sprintförmågan. Läs igenom informationen noga och ge ditt medgivande genom att signera ditt namn nederst på sidan.

Jag medgiver att jag:

- Har tagit del av informationen kring studien förstår vad den innebär.
- Har fått ställa de frågor jag önskar och vet vem som är ansvarig huvudman om jag har fler frågor.
- Deltar frivilligt i studien och förstår varför jag har blivit tillfrågad.
- Vet att jag när som helst kan avbryta mitt deltagande i studien utan att ange orsak.

Jag intygar att jag har läst det informerade samtycket och tagit del av informationen kring studien. Jag förstår vad deltagande i studien innebär och ställer upp frivilligt.

Ort och datum___________________________________________________________

Namn_________________________ Underskrift____________________________

Ort och datum____________________________________________________________

Underskrift vårdnadshavare______________________________________________
Appendix 2: Foam rolling routine

In all routines use your body weight to create pressure. Use the foam roller 30 seconds on each muscle. Always start with the right and then move to your left. In 30 seconds move forward and back from the origin to the insertion of the muscle with a constant speed and pressure. The participant should feel a pressure on the massaged muscle but have to decide for them self so that it is not painful. The information below is written in the right order the routines were performed.

Foam rolling routine

**Gluteus**  Sit on the foam roller with the right gluteus. Keep your left leg bent with the foot on the floor. Put your right foot on the left knee. Use the hands and arms to lift the body up. Roll from the origin to the insertion of the muscle.

**Hamstrings**  Place the foam roller under hamstring. Lift the body up with your arms and use your bodyweight to create pressure. Roll forward and back from the origin to the insertion of the muscle.

**Triceps surae**  Place the foam roller under your right triceps surae. Lift your body up with your arms. You can chose to add more pressure by placing your left foot over the right or less pressure by keeping the left foot on the floor. Move from the origin to the insertion of the muscle.

**Adductors**  Place the foam roller under the inside of your thigh. Lie on your stomach with the right leg in 90 degrees hip abduction and outward rotation. Bend the right knee to 90 degree. Roll from side to side from the origin to the insertion to the adductor muscles.

**Quadriceps**  Place the foam roller under the right front thigh. Roll forward and back by using your arms and the left leg. Move from the origin to the insertion of quadriceps.
Appendix 3: Dynamic stretch routine

The dynamic stretch routine should be performed while walking 20 meters forward and back. On exercise was performed over 20 meters and while changing direction also exercise was changed. The routine was performed two times in a row.

Dynamic stretch routine

**Hamstrings**  Walk and swing the leg forward in hip flexion until feeling a stretch in hamstrings. Keep the swinging leg straight.

**Gluteus**  Walk forward and bring the knee against the chest as high as possible.

**Adductors**  Bend the knee and bring it out so that there is an abduction and outward rotation in the hip. Bring the knee forward in a step. The movement looks like you are walking over hurdles.

**Quadriceps**  Move the heels towards your buttocks while walking forward.

**Triceps surae**  Walk on your toes and dynamically plantar flex alternating foot.
Frida Linderoth