The use of mat Pilates exercises for improving acute flexibility in female amateur soccer players

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Abstract

The aim of the present study was to assess the acute effect of selected mat Pilates exercises on the lower extremities joint flexibility of female amateur soccer players. Eighteen volunteers, all female amateur soccer players, with a mean age of 25.6±3.5 years old, mean height of 168.3±2.8 cm, mean body mass equal to 66.4±6.2 kg and mean training age of 13.5 years, lacking prior Pilates knowledge, formed the study's sample. All players performed two different mat Pilates protocols on non-consecutive sessions, in random order. The first protocol included initial flexibility measurements, selected mat Pilates exercises performed in full ROM and final flexibility measurements. The second protocol was similar to the first, expect for the mat Pilates exercises, where the joints were not in full ROM. Ten repetitions were performed for each exercise (1x10) before equal repetitions were performed on the alternate leg (2x10). Range of motion (ROM) was measured passively on hip flexion, hip extension, hip abduction, knee flexion and ankle dorsiflexion on the right side of the body, with the use of a flexometer. A 2x2 Analysis of Variance for repeated measures was used in order to verify differences between pre- and post-measurements for both mat Pilates protocols. The study revealed that the selected mat Pilates exercises produced significant effects on the joint flexibility only when performed in full ROM. The findings suggest the use of mat Pilates exercises as an alternate training method for improving joint flexibility among soccer players, only when performed in full ROM.

Keywords: Flexibility, range of motion, Pilates mat, amateur players, soccer.

Introduction

Flexibility consists of an important component of physical fitness, describing the ability of a joint to move in a full range of motion (ROM) without inducing stress to the musculotendinous unit (Chandler et al. 1990).

In athletes and in soccer players in particular, adequate flexibility helps the biomechanical accuracy of competitive movements by improving muscle function (Van Gyn 1986). Flexibility is considered as a pivotal factor for the performance of skilful movements during a match (Garhammer 1989), additionally contributing to improving the assists of soccer players and one-on-one charging. On the other hand, poor flexibility is considered as a factor restricting sports performance due to the reduced ROM (Wilson et al. 1991) and can lead to the rupture and injuries of either the muscle or the connective tissue (Stone et al. 1991). Muscle tightness is a known factor contributing to the development of muscle strains (Ekstrand and Gillquist 1983), whereas adequate flexibility is unanimously accepted as a criterion preventing and minimizing injuries (Corbin and Noble 1980).

According to scientific research, joint ROM can be increased with the implementation of muscle elongation exercises (Roberts and Wilson 1999, Zakas et al. 2006, Famisis 2015). The main techniques used today involve static stretching and dynamic elongation. Although static stretching techniques are widely used among athletes, they only induce elongation on the competitive muscles involved in the exercise without ameliorating other physical fitness components such as muscle strength, power and movement coordination, all equally important in soccer. Improvements in the length of the competitive muscles with concurrent improvements on all of the aforementioned physical fitness components can also be achieved with the implementation of dynamic exercises performed in a slow and controlled manner, in full joint ROM (Fredrick and Szymanski 2001, Hedrick 2000).

Pilates is an additional technique, improving dynamic muscle elongation. It can be performed in a slow and gentle pace, in full joint ROM, akin to the gentle dynamic stretching exercises (Latey 2002), without inducing musculoskeletal stress. Pilates was named after its creator, Joseph Pilates (1880 until 1967) and is considered safe and appropriate for all age groups and body (Caldwell et al. 2009). Initially, it was adopted by professional dancers (Lange et al. 2000), however, during the final years it grew popular among women and the clinical and fitness areas (Lange et al. 2000, Segal et al, 2004). The implementation of Pilates confers a plethora of benefits among all age groups, ranging from increased flexibility, movement coordination, muscle power and strength, body posture and balance, agility, as well as adaptation and perception (Siler 2000, Phrompaet et al. 2011).

Soccer fitness focuses on strength, endurance, coordination, flexibility and agility, making it the one of the most physically demanding sports in the world. Furthermore, soccer coaches also emphasize muscle balance and flexibility in preventing musculoskeletal injury (Smith1994). Nowadays, an increasing number of athletes and in particular soccer players implement personalized Pilates exercise programs and few coaches tend to incorporate the technique in their training protocol as a means to increase flexibility and reduce injuries (Bertolla et al. 2007). The most preferred exercises adopted in soccer involve mat Pilates exercises, as a body of scientific evidence suggest its effect in improving flexibility (Sekendiz et al. 2007, Bertolla et al. 2007, Rogers and Gibson 2009, Amorim et al. 2011, Kloubec 2010) while additionally, these exercises are easy to implement and teach and can be performed simultaneously by several individuals, without the need for immediate personalised surveillance and guidance (Cruz-Ferreira et al. 2011).

The majority of research showing improvements in joint flexibility has used longitudinal mat Pilates protocols, lasting for several weeks and in a variety of samples. Thus, there is a lack of studies assessing the acute effects of mat Pilates exercises on the flexibility of athletes. Sekendiz et al. (2007) used a 5-week protocol on a sample of sedentary adult females with a mean age of 30 years old, whereas Rogers and Gibson (2009) performed a protocol lasting for 8 weeks among healthy young adults (mean age 25.5 years). The longest protocol was implemented by Kloubec (2010) and lasted for 12 assessing flexibility among healthy active middle aged people (age range 25-65years), whereas Amorim et al. (2011) used an 11 weeks protocol on adolescent dancers and Bertolla et al. (2007) performed a 4 week protocol on futsal soccer players with a mean age of 17.8 years.

Joint flexibility can be improved in a single training session with the use of dynamic type exercises, such as calisthenics, only when they are performed in full joint ROM (Famisis 2015). As far as mat Pilates exercises are concerned, research has also showed the need for attainment of full joint ROM during implementation in order to induce improvements on flexibility (Latey 2001). Since the technique involved in dynamic type exercises is similar to that of mat Pilates, it would be useful to assess the acute effect of mat Pilates on joint flexibility after the implementation of a single training session, with the performance of the exercises in both full and restricted joint ROM.

Thus, the aim of the present study was to assess the acute effect of mat Pilates exercises performed in a full and restricted ROM, on the flexibility joints during hip flexion, hip extension, hip abduction, knee flexion, and ankle dorsiflexion, in a sample of female amateur soccer players.

Methods

Participants

The sample of the study consisted of 18 volunteers, all female amateur soccer players, with a mean age of 25.6±3.5 years old, height of 168.3±2.8 cm, body mass of 66.4±6.2 kg and a training age of 13.5±2.2 years. The study was performed 20 days after the end of the competitive season. During these 20 days, all players were involved in light soccer training sessions as well as in learning and implementing the mat Pilates exercises included in the training protocols. A certified Pilates trainer taught and supervised the procedure. During the 20 days following the competitive season, the athletes participated in a total of 5 light soccer training sessions and 9 sessions concerning the implementation and proper performance of mat Pilates exercises. The mat Pilates training lasted for 7 days, prior to the initiation of the study. Each athlete agreed to restrain from any type of strenuous physical activity for 7 days prior to and during the implementation of the study. All participants were healthy, without a history of musculoskeletal injuries or neurological disease. A sports medicine accredited doctor examined each female player physically before the beginning of the experiment. All participants and the coaches were informed of the nature, aim and possible risks associated with the study before providing their consent for participation. For the duration of the study, athletes were allowed to maintain their everyday activities. The training protocol was performed indoors, in yoga and Pilates equipped hall. The study was conducted in accordance to the rules and regulations of the research Ethics Committee of the Aristotle University of Thessaloniki.

Training Protocols

All participants performed 2 different protocols on non-consecutive sessions, each separated by at least 1 week from next, for every subject. The order the protocols were preferment was random so that the results would not be affected by learning factor. The experimental protocol involved selected mat Pilates exercises all involved in elongating the competitive muscles of the measured joints. Before the implementation of the protocol an introductory pre-Pilates session was administered, lasting for 5 minutes, aiming to prepare the spine and trunk for the neutral positioning needed during the performance of Pilates. For both experimental protocols the exercises were the same, were performed under the same conditions and in a constant non-stop manner, rhythmically, with the use of slow and gentle movements in accordance to breathing. Each exercise was performed 10 times and was repeated once more for the alternate limb (2x10 in total), in order to eliminate time gaps and reduce the onset of muscle fatigue.

The first protocol comprised of a) initial flexibility measurements, b) selected exercises performed in a full joint ROM, and c) final flexibility measurements. The working muscle groups were the hamstrings, quadriceps, adductors, hip flexors and soleus. The second protocol was akin to the first, expect for the implementation of the mat Pilates exercises, where the joint ROM was restricted. The working muscle groups, were the same as on the first protocol, being the hamstrings, quadriceps, adductors, soleus and hip flexors.

Both training protocols were performed in the same hall, during the same time of the day, by the same experienced researchers. During the study, the same researcher was responsible for the same activities. Preliminary information was provided to the participants concerning the implementation of the protocols. The results of the measurements were recorded by the same researcher.

Mat Pilates exercises

Each mat Pilates exercise used was selected on the basis of the muscle groups involved during its implementation. A total of 5 exercises were selected, each involving one of the examined muscle groups. The Pilates protocol included the following exercises: (1) The *Single Straight Leg Stretch*, for the dynamic elongation of the rear thigh muscles. (2) The *Front-Back*, for the dynamic elongation of the iliopsoas muscle. (3) The *Up-Down*, for the dynamic elongation of the adductor muscles. (4) The *Single Leg Kick*, for the dynamic elongation of the front thigh muscles. (5) The *Leg Pull Down*, for the dynamic elongation of the rear calf muscle groups. A certified Pilates trainer selected the exercises and supervised their implementation by the participants.

Flexibility measurement

Five lower extremities ROMs (hip flexion, hip extension, hip abduction, knee flexion and ankle dorsiflexion with the knee flexed) were measurement prior to and after the exercise protocol. All joints were measured with a Myrin flexometer (Lic Rehab. 17183 Solna, Sweden), by the same experienced researcher, in accordance to the Ekstrand et al. (1982) method. The used flexometer consists of a modification of the Leighton flexometer and comprises of one circular scale with a weighed pointer controlled by gravity, attached to its centre. The variation coefficient for the goniometric measurements method was high (1.9±0.7%).

All measurements except for ankle dorsiflexion were performed on an adjustable bench on the right side. Only the right side was measured because the statistical analyses of the recruitment data failed to show significant differences between the right and left body sides of the participants ($p>0.05$). Each movement's initial and final positions were passively measured starting from a 0° point, as defined by the American Academy of Orthopaedic Surgeons (1965). Maximal flexibility was determined as the point where the joint attained end-range, which, in term, was defined as the point at which the examiner felt muscle restriction (Ferber et al. 2002). All pre-test and post-test measurements were taken at approximately the same time of day, while participants abstained from any training or other type of exercise for the 48h preceding the experiment. The reliability coefficient of each measurement was high: $r=0.90$ for the hip flexion, $r=0.92$ for the hip extension, $r=0.92$ for the hip abduction, $r=0.90$ for the knee flexion and $r=0.92$ for the dorsiflexion.

Statistical Analyses

A 2x2 model of analysis of variance (ANOVA) with repeated measures in both factors was used to analyse the results. The measurement of flexibility consisted of the first factor, with two stages, the initial and post-exercise measurements. The Pilates exercise protocol consisted of the second factor, having two stages, being the full and restricted joint ROM. Differences between factors were assessed with the use of paired t-tests. In regards to the lateral deviation, data from the right side were only used, as no significant difference was observed when both body sides were compared during the baseline measurements. The statistical significance was set at 95% ($p\leq0.05$).

Results

The statistical analysis revealed a highly significant test for mat Pilates flexibility interaction during hip joint flexion ($F=32.26$, $p\leq0.001$), extension ($F=14.34$, $p\leq0.001$) and abduction ($F=33.25$, $p\leq0.001$), knee joint flexion ($F=12.14$, $p\leq0.001$), and ankle joint dorsiflexion ($F=19.45$, $p\leq0.001$), suggesting that the effect of mat Pilates exercises is depended on the examined protocol. To further break down this interaction, paired t-tests were separately performed for each mat Pilates flexibility protocol in order to examine differences in each joint ROM prior to and after the implementation of the mat Pilates regimen. A significant increase ($p\leq0.001$) was observed in all joint ROM (Figures 1-5) after the performance of the Pilates protocol in full joint ROM. In contrast, no differences were observed in joint ROM when the same Pilates protocol was performed in restricted joint ROM.

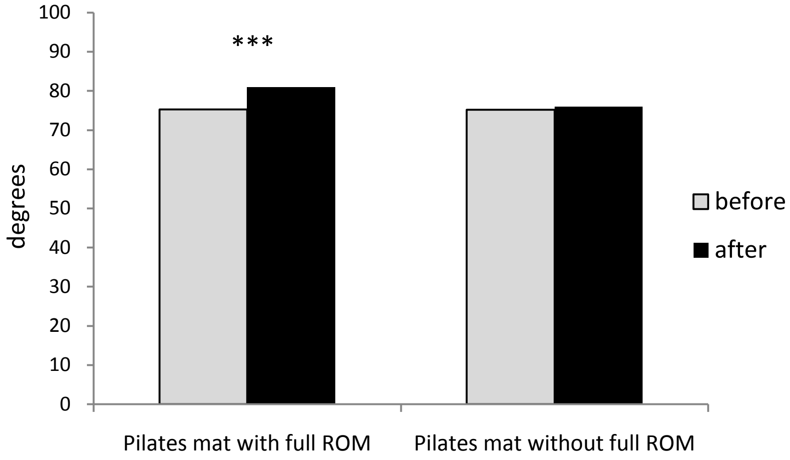

Figure 1. Female amateur soccer players' range of motion during hip flexion, before and after the implementation of the selected mat Pilates exercises performed in full and restricted ROM. *** $p \leq 0.001$.

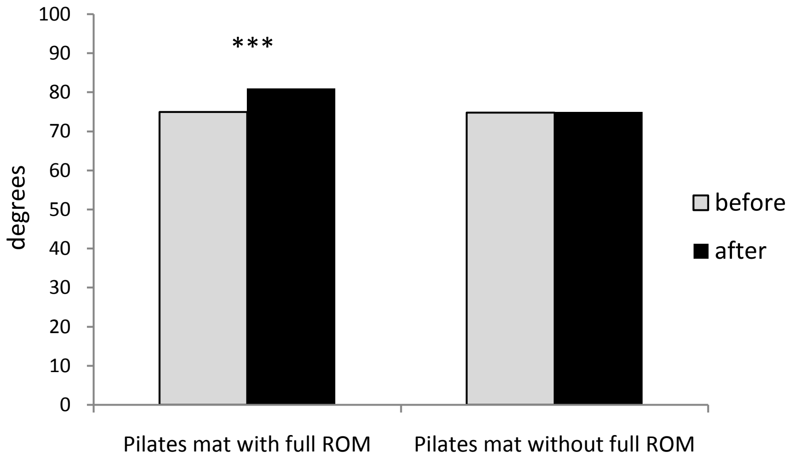

Figure 2. Female amateur soccer players' range of motion during hip extension, before and after the implementation of the selected mat Pilates exercises performed in full and restricted ROM. *** $p \leq 0.001$.

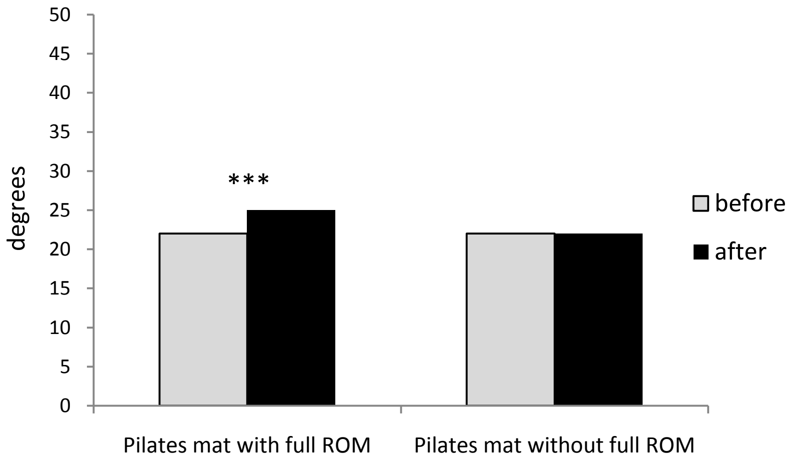

Figure 3. Female amateur soccer players' range of motion during hip abduction, before and after the implementation of the selected mat Pilates exercises performed in full and restricted ROM. *** $p \leq 0.001$.

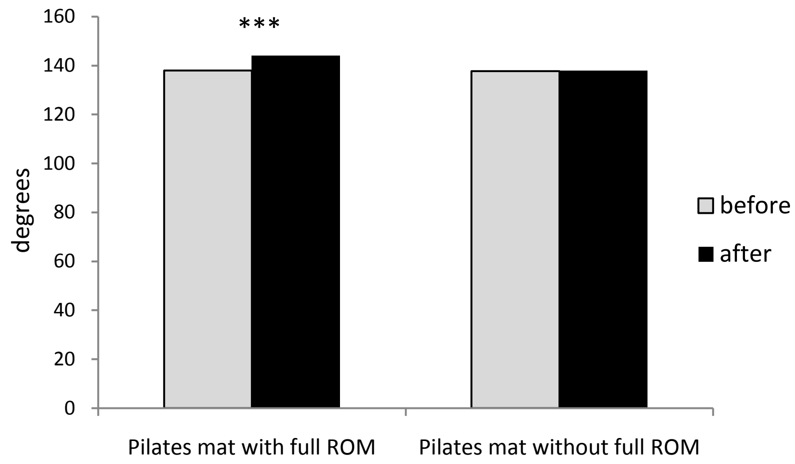

Figure 4. Female amateur soccer players' range of motion during knee flexion, before and after the implementation of the selected mat Pilates exercises performed in full and restricted ROM. *** p≤0.001.

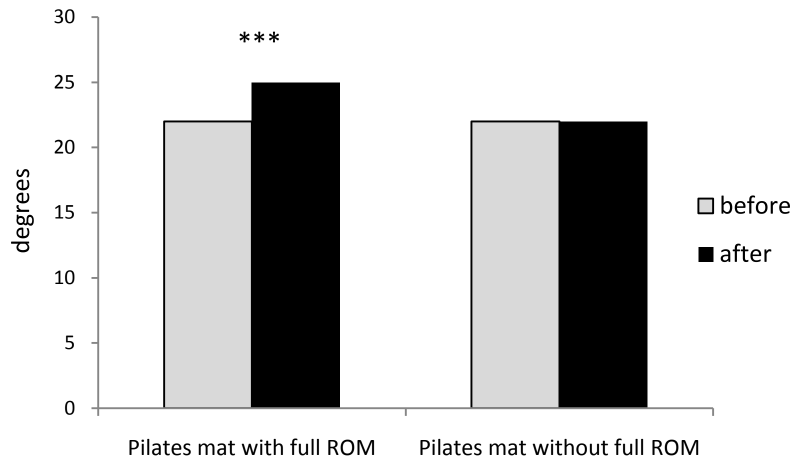

Figure 5. Female amateur soccer players' range of motion during ankle dorsiflexion, before and after the implementation of the selected mat Pilates exercises performed in full and restricted ROM. *** p≤0.001.

Discussion

Given the fact that an increasing amount of soccer players today tend to incorporate Pilates exercises on their training schedule, the present study was designed to evaluate the acute effects of selected mat Pilates exercises on the lower extremities joint flexibility of female amateur soccer players, when the exercises are performed in full or restricted joint ROM.

The results showed that selected mat Pilates exercises repeated 10 times for each limb induced significant improvements in joint ROM only when performed in a full ROM. Unfortunately, the findings herein cannot be directly compared to other studies due to methodological differences, as well as differences in the studied muscle groups, however the pivotal impact of long-term Pilates training on the flexibility of sedentary subjects (Sekendiz et al. 2007, Rogers and Gibson 2009, Kloubec 2010), dancers (Amorim et al. 2011) and futsal soccer players (Bertolla et al. 2007), has already been documented in literature.

Improvements in joint flexibility can be attained with the implementation of dynamic type exercises such as calisthenics, as seen in amateur soccer players (Famisis 2015) as well as in adolescent tennis players (Zakas 2005). Famisis (2015) reported significant flexibility improvements during hip flexion, hip extension, hip abduction, knee flexion, and ankle dorsiflexion in a single training session performed by amateur soccer players, when the exercises are performed for a duration of 10 seconds and repeated once more in full ROM. Zakas (2005) also noted significant flexibility improvements on the lower extremities joints after the implementation of a single regular tennis warm-up session, performed in full ROM, under field conditions. Improvements of joint flexibility can also be attained with the use of a single static stretching session, as shown in amateur soccer (Famisis 2015) and junior handball players (Zakas et al. 2003).

According to the present findings, the selected mat Pilates exercises repeated 10 times, failed to improve flexibility when not performed in full joint ROM. Therefore, the implementation exercise in a full ROM appears to be the criterion improving flexibility when mat Pilates exercises are performed. Despite the inability to directly compare the present findings to previous research, it is important to note that similar findings have been reported by studies assessing the effects of dynamic type exercises, showing improvements in flexibility only when the exercise protocol was performed in full joint ROM (Famisis 2015, Zakas 2005). Therefore it becomes evident that joint flexibility can be significantly improved in a single training session, whether the competitive muscles are elongated in a dynamic or static manner, as long as the joints are moved in full ROM. As Van der Poel (1998) has promptly noted, muscle length is completely depended on the way the muscle is used during each movement.

Although the aims of the present study did not include the assessment of possible aetiological mechanisms affecting joint ROM, according to scientific literature, flexibility improvements are mainly attributed to alterations in the extensibility of the connective tissue, as adequate/poor joint flexibility is considered to be dependent on the length and elasticity of the connective tissue surrounding individual muscle fibres and the muscle in total (Sapega et al. 1981, Warren et al. 1976, Alter 1996, Wallmann 2009). However, the positive impact of connective tissue on flexibility appears overestimated by researchers, whereas the effects myogenic constraints in determining ROM appear underestimated (Hutton 1992). Supporters of this theory, like Hill (1968) as well as Magid and Law (1985), postulate that during active/passive muscle elongation the disconnection of myosin cross-bridges from act in is the actual root cause resulting in increased muscle length. However, further research is needed in order to delineate the exact mechanisms involved in the joint flexibility conundrum.

Conclusion

The results of the present study indicate that joint flexibility can be improved when dynamic elongation of the muscles is induced through Pilates exercises performed in full joint ROM. Additionally, the findings suggest that the dynamic muscle elongation attained through mat Pilates does not appear to overt increments in joint flexibility when the exercises are not performed in full joint ROM.

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