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Acute effect of short duration hatha yoga exercises on flexibility in soccer players

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ABSTRACT

To date, the acute effect of selected hatha yoga exercises performed on a single training session on the joint flexibility of amateur soccer players has never been examined. The purpose of the present study was to examine the acute effect of short duration selected hatha yoga exercises on flexibility of the lower extremities and trunk in amateur soccer players. A total of 18 players (25.6±2.8 years old), with a mean training age of 16.5 years volunteered to participate in the study. All participants performed five (5) selected hatha yoga asanas in a total of 15 sec (1x15 sec) each, alternately for each leg, which were repeated once more for the same duration (2x15 sec). The duration of each asana reached 4 sec to obtain the final position, 9 sec to maintain the final position, and 2 sec to return to the starting point (total=15 sec). During these 9 sec, the stretching positions were performed dynamically, using very gentle pulling, without any discomfort, so that the player only felt the elongation. The range of motion (ROM) was determined during hip flexion, extension and abduction, as well as during knee flexion and ankle dorsiflexion with the knee flexed, as well as during trunk flexion using two types of goniometers. Paired t-tests revealed significant improvements in the ROM of all measured joints ($p<0.001$). The results indicated that dynamic stretching of the muscles with a very gentle pull for 9+9 sec consists of a positive stimulus to improve lower extremities and trunk flexibility among adult amateur soccer players.

KEYWORDS: asana, female soccer players, hatha yoga, range of motion.

1. INTRODUCTION

Stretching was first coined during ancient times. According to archeological findings, ancient Greek athletes used to incorporate flexibility exercises in their training protocol, in order to prepare for acrobatics, wrestling or other sports [1]. Flexibility consists of an important fitness component, defined as the ability to perform joint movements through the normal range of motion (ROM), without inducing stress to the underlying musculotendinous unit [2]. On the other hand, inflexibility is defined by a confined ROM, mainly as a result of competing muscles shortening [3]. Adequate or poor joint flexibility is attributed to connective tissue elasticity, in particular that surrounding the myofibrils and the whole muscle [3,4]. According to Hutton [5] however, as far as flexibility is concerned, the role of the connective tissue appears to be overestimated.

Soccer consists of the most popular sport worldwide [6], involving a plethora of different motor actions performed during match play, all at various intensities. These movements require good joint flexibility, or at least normal ROM, as well as increased power and strength, including accelerations, decelerations, jumping, cutting, pivoting, turning, and kicking of the ball. [7] Among soccer players, attaining adequate flexibility acts supportively towards the performance of skillful tasks and movements, coordination and biomechanical precision, while allows the application of dynamics for a longer duration and over a larger ROM [8]. Several stretching techniques, including static, proprioceptive neuromuscular facilitation (PNF), ballistic and dynamic stretching, aim in improving joint ROM [9,10]. Static stretching in particular, can be either active, or passive [11]. Active static stretching involves retaining the stretched position, while using the strength of the agonist muscle.

Athletes, and specifically soccer players, perform static stretching routines after a mild aerobic activity, as part of a pre-exercise warm-up session [12], considering this as the safest method to exercise [9,10,13], due to its relatively easy applicability [14] and low injury risk [15]. In parallel, it is also viewed as a means to successfully increase joint ROM [16].

Static stretching is performed routinely in order to improve performance [17], decrease muscle soreness [18], while reduce injury risk [16]. However, regarding the latter, Shrier [19] disagrees on whether flexibility can in fact minimize injury risk.

Static and dynamic stretching can both increase flexibility [20,21], although more recently, yoga has also been included in the training protocols [22]. The most recognizable form of yoga practiced in the West is hatha yoga, which concentrates on the physical health and well-being.

Yoga encompasses the practice of postures (asanas) for strength and flexibility, breathing techniques (pranayama) to develop self-awareness and meditation help to calm the mind [23]. Hatha yoga is performed in a manner similar to the active static stretching, with the agonist muscles applying a concentric type of contraction, followed by an eccentric contraction upon returning to the starting point [11]. Maintenance of the final joint position, during which static stretching is applied, is performed by stabilizing the body through isometric muscle function applied by the competing muscles [24,25]. In this position, the athlete is encouraged to keep still, or maintain a continuous gentle pull of the extensor muscles, while feeling the stretched muscles being elongated [26].

Hatha yoga can act as an alternative form of exercise during muscle recovery after the performance of an intense exercise session, while relaxing the body and tampering down heart rate [25,27]. In parallel, since many muscle groups are used when hatha yoga is implemented, it can also be used to improve physical fitness, through the application of dynamic and isometric muscle force [24,25]. Through the different asanas, incorporation of hatha yoga in the training session can induce benefits in the muscle strength and endurance, coordination and flexibility [28]. In each asana, breathing is performed through a deep exhale during the joint's return to the starting position. Deep breaths are also performed throughout maintenance of the extreme joint position [29]. In hatha yoga, the time spent in the extreme joint position is of pivotal importance in improving flexibility. The minimum duration each asana should be maintained spans between 30 sec, until several minutes and is repeated more than once [29], depending on the performance style [30].

For static stretch, the duration of execution for each exercise is correspondingly long, ranging from 10–30 sec, increasing the total duration to approximately 60 sec with repetitions [31]. Although, as already mentioned, the role of the connective tissue as the main benefactor for attaining either adequate, or poor flexibility [5] may actually be overestimated, a long duration of muscle elongation at the extremity appears to positively affect joint ROM. Thus, given that the muscle is not purely elastic, but rather viscoelastic [32], long duration extensions are deemed necessary for activation of the elastic properties of the connective tissue, reduction of viscoelasticity via the induced lowering of the muscle-tendon unit stiffness [26,33].

Nowadays it is acknowledged that practicing hatha yoga improves joint ROM [25,34,35]. Several authors have investigated the effect of frequent yoga practice for several weeks among young [36], middle-aged [34] and older adults [37], but also among athletes, although research in this latter population is still limited [35,38]. In further detail, Grabara [36] reported improvements in the flexibility of young adults (19–22 years old), when applying a total of 90 min exercises, once a week, for a total of 13 weeks. Amin and Goodman [34] observed similar improvements among middle-aged women (40–65 years old), after the performance of a 90 min session every week, for a total of 6 weeks. Similar improvements in the flexibility were also observed by Grabara and Szopa [37] among aged above 50 years, after the implementation of a 90 min comprehensive program, once per week, for 20 weeks in total. Among athletes, Iftekher et al. [38] reported improvements in the flexibility of shooting athletes after the performance of hatha yoga exercises, twice a week, for 7 weeks in total. Similar findings were observed by Polsgrove et al. [35] in a sample of college soccer and baseball athletes, when hatha yoga was performed for 10 weeks in total. To our knowledge, no study has investigated the acute effects of hatha yoga on the flexibility of untrained, or amateur soccer players, although it is acknowledged that flexibility is improved gradually, in every training session [39].

Despite the fact that researchers tend to disagree on the ideal stretch duration for each hatha yoga asana, most studies report that stretching must be performed for at least 30 sec, in order to induce connective tissue adaptation and improve flexibility.

In addition, to date, a great amount of research is focused on identifying the ideal duration needed for the asanas to be effective. With the majority of soccer players avoiding the performance of long stretching sessions, it would be of use to determine the acute effect of yoga exercises of shorter duration, on joint flexibility. Therefore, the purpose of the study was to examine the acute effects of short duration of selected hatha yoga exercises on flexibility in the lower extremities and trunk in amateur soccer players.

2. MATERIALS AND METHODS

2.1 Participants

Eighteen adult, amateur soccer players volunteered to participate in the study. The protocol was initiated at 15 days directly after the end of the competitive session. During the "latent" 15-days' time, athletes participated in a total of 4 light-intensity soccer-specific training sessions. Additionally, all participants agreed to restrain from all forms of strenuous physical activity throughout the study protocol. Inclusion criteria involved 1) adult, 2) healthy, free of any musculoskeletal injury or disease, 3) amateur soccer players, 4) who were main players in their teams, 5) without any previous hatha yoga experience, 6) willing to participate in the study, while 7) abstaining from any form of strenuous physical activity throughout the study protocol. Exclusion criteria involved 1) children and adolescents or 2) professional soccer players, or 3) amateur soccer players who did not form as main players in their teams, 4) those unable/unwilling to abstain from any form of strenuous physical activity throughout the study protocol and 5) those not providing informed consent. Participants were introduced to the hatha yoga asanas a week before the initiation of the study's protocol.

2.2 Pre-protocol health examination

At the beginning of the study, height and weight of participants was measured at morning hours with a Seca 789 Scale (Seca, Hamburg, Germany) and the subjects wearing light clothing. An accredited sports medicine doctor examined each participant thoroughly, before the initiation of the protocol.

2.3 Ethical permission

All athletes and their coaches, were informed of the nature, aim and possible risks associated with the study, before providing informed consent to participate. The study was conducted in accordance to the rules and regulations of the research Ethics Committee of the Aristotle University of Thessaloniki (Thessaloniki, Greece) and the Helsinki declaration for research on human subjects.

2.4 Experimental Protocol

All participants individually performed one session of the same exercise protocol, without any prior warming up. The protocol included the performance of selected hatha yoga exercises aiming in elongating the lower extremities and trunk muscles. The hatha yoga protocol included 5 asanas performed in a continuous manner on both sides of the body (right and left), without any time breaks between the asanas. Each asana was performed alternately on either side, except for the "*Closed Vise Pose*" and "*Bow Pose*" asanas, that were performed only once. The postures/asanas used to investigate the research hypothesis were selected according to the joints or interest. They consisted of routine posture/asanas or variations of common hatha yoga asanas. Each posture was initiated at the same time, with subjects inhaling slowly and deeply throughout, while the movement at the extreme position was accompanied by slow exhalation, similarly to the return to the starting point position. When reaching the extreme position, the practitioner remained for the rest of the time for each exercise, performing as many inhalations and exhalations as required, for that particular time. In each posture/asana, the time taken to reach to the end position was 4 sec, the end position was reached at 9 sec, and the return to the starting point was lasted for 2 sec (4+9+2=15 sec in total). In each posture, when reaching the extreme position, stretching was performed with continuous, very gentle pulling of the stretching muscle groups, with the subjects feeling only a slight stretching of the selected muscles for a total of 9 sec, without any discomfort, or pain. The selected postures/asanas cycle was repeated in the exact same manner for a second time, for each targeted muscle and muscle group. In the first cycle, the total time spent at each asana was 15 sec (1x15) for each side of the body (right side 15 sec and left side 15 sec) and was repeated once (1x15) in the second cycle (2x15).

2.5 Hatha yoga exercises

The hatha yoga asanas applied were selected according to the joints of interest. The exercises included 1) the *"Closed Vice Pose" (Pascimottanasana),* aiming to elongate trunk muscles, 2) the *"One Leg Extension" (Ekapadapascimottanasana),* for elongation the muscle groups of humstrings and soleus, respectively, 3) the *"Runner's Pose" (Utthita Ashwa Sanchalanasana),* for the elongation of the iliopsoas, 4) the *"Side Warrior Pose" (Parsvavirabhadrasana),* for the stretching of the adductor muscles and 5) the *"Bow Pose" (Dhanurasana),* for the elongation of quadriceps muscles. An experienced trainer specialized in hatha yoga selected the exercises.

2.6 Flexibility Measurements

ROM of the lower extremities and trunk was measured for all participants at baseline and at the end of the experimental protocol. A total of five ranges of motion of the lower extremities (hip flexion, hip extension, hip abduction, knee flexion and ankle dorsiflexion with knee flexed) were examined, in parallel to trunk flexion. All measurements were taken before, and immediately after the performance of each stretching protocol.

For hip abduction flexibility, a specially constructed double protractor goniometer was used. The remaining asanas were measured with a Myrin flexometer (Lic Rehab. 17183, Solna, Sweden), which consists of a Leighton flexometer modification, having a circular scale with an attached weighed pointer controlled by gravity. The Sady and associates [15] method was used to measure trunk flexion was measured (reliability coefficient r=0.94). All other flexibility measurements were assessed based on the procedure suggested by Ekstrand, Wiktorsson, Oberg, and Gillquist [40], with a high reliability of variation coefficient (1.9±0.7%) for all of the goniometric measurements. An adjustable bench was used for all measurements, except for the ankle dorsiflexion. Ranges of the lower extremity joints were randomly measured once on either side of the body. For each posture, initial and final positions were measured passively, starting from a 0° point, as suggested by the American Academy of Orthopaedic Surgeons [41]. Maximal flexibility was defined as the point reaching the end-range of the joint, which, in turn, was defined as the point at which the subjects had the feeling of muscle restriction [42].

All measurements were performed by a pair of experienced researchers, both experienced and familiar with measuring joint ROM. One was assigned as a tester, and was responsible for the maximal passive movement of the joints of interest. The second one served as an observer, supervising the measurements. Throughout the experiment, the same researchers were assigned to the same tasks. All measurements were performed at approximately the same time of day. Prior to the baseline flexibility measurements, subjects abstained from conducting any warming-up exercises, and participation to any training program, or other type of exercise was forbidden during the 48h preceding the study. The reliability coefficient of each measurement was high, reaching r=0.92, r=0.91 and r-0.93 for hip flexion, extension, and abduction, respectively. The reliability coefficient of the knee flexion reached r=0.91, whereas, similar coefficients were noted concerning ankle dorsiflexion (r=0.92) and trunk flexion (r=0.91).

2.7 Statistical analysis

All data were normally distributed. Descriptive statistics, including mean and standard deviation (SD) were calculated for the dependant variable of lower extremities and trunk flexion flexibility. A two-tailed paired t-test was applied to determine the significance of the relationship between the means of each group. In addition, a two tailed student's t-test was applied to evaluate any flexibility differences between the two legs among participants. Data were analyzed using SPSS (Statistical Package for Social Science) version 22.0. The level of significance was set as $p<0.05$.

3. RESULTS

Mean age of the participants was 25.6±2.8 years, height was measured at 172.3±3.2 cm, and body mass 72.7±5.9 kg. The sample had an average training age of 16.5 years. Mean baseline mean ROM comparison between right and left body sides (using the two legs) was similar among every measured joint (Table 1). Thus, only the results of the right side of the body are presented, since the statistical analyses failed to indicate the existence of differences between the right and left body sides among participants ($p>0.05$). A significant increase was observed in all joint ROMs ($p<0.001$) immediately after intervention training protocol in amateur soccer players (Table 2), indicating that the flexibility is influenced by the hatha yoga training protocol. The improvement rates were for the hip flexion 4.1 degrees, hip extension 4.4 degrees, hip abduction 4.6 degrees, knee flexion 4.0 degrees, ankle dorsiflexion 4.5 degrees and the trunk flexion 4.5 degrees. The results are presented in Table 2.

Table1. *Baseline measurements of the right and the left side of the body during hip flexion, extension and abduction, as well as during knee flexion and ankle dorsiflexion in 18 amateur soccer players before implementation of the hatha yoga training session (Mean ± standard deviation).*

Dependent Variables	**Right**[1]	**Left**[2]	**T**	***p***
Hip flexion	77.7 ± 7.0	77.8 ± 7.2	-0.14	NS
Hip extension	81.2 ± 4.4	80.4 ± 4.4	1.16	NS

Hip abduction	40.6 ± 7.3	40.2 ± 7.0	0.22	NS
Knee flexion	144.6 ± 8.0	144.8 ± 8.4	-0.26	NS
Ankle dorsiflexion	23.4 ± 4.2	23.2 ± 4.4	0.71	NS

[1]Right side of the body; [2] Left side of the body; NS: not significant.

Table2. *Six ranges of motion in 18 amateur soccer players initially and immediately after implementation of the hatha yoga training session (Mean ± standard deviation).*

Dependent variables	**Baseline**[1]	**Post-yoga**[2]	**T**	***p***	***Cohen's d***
Hip flexion	77.7 ± 7.0	81.8 ± 7.4	-5.78	<0.001	0.57
Hip extension	81.2 ± 4.4	85.6 ± 4.2	-7.96	<0.001	1.02
Hip abduction	40.6 ± 7.3	45.2 ± 7.7	-8.78	<0.001	0.61
Knee flexion	144.6 ± 8.0	148.6 ± 7.4	-6.81	<0.001	0.52
Ankle dorsiflexion	23.4 ± 4.2	26.9 ± 4.8	-5.13	<0.001	0.77

1. Baseline measurements; [2] Measurements after implementation of the hatha yoga training session.

4. DISCUSSION

The present study was designed to examine whether performing selected hatha yoga exercises is effective in improving lower extremities and trunk joint ROM among amateur soccer players. The results collectively indicate that extending the antagonist muscles for 9 sec at each hatha yoga posture, with two repetitions of the same time after approximately 2 min, consists of a positive stimulus for improving joint ROM, and by inference, efficient in improving stretching muscles elongation.

The findings herein cannot be directly compared to similar studies conducted among soccer players, athletes or other population, mainly due to methodological differences. However, the results are in agreement with similar protocols results that performed static stretching in acute conditions in soccer players [43,44] and handball players [45], as well as with results from protocols examining the effects of hatha yoga asanas in athletes [35,38] and untrained individuals of various age groups [34,36,37].

In further detail, Polsgrove et al. [35] observed improvements in the flexibility of shoulder, hamstring muscles, and lower body back, measured with the seat and reach test, on 14 soccer college players and 12 baseball college players, after a total of 10 weeks of regular yoga training. Similar improvements were noted by Iftekher et al. [38] concerning the hamstring muscles and lower body back, measured using the seat and reach test among 20 shooting trainee athletes, after a 7-week yoga training program. Flexibility improvements have also been reported among young [36], middle-aged [34] and older adults [37], after the implementation of yoga exercises for a total of 13, 6 and 20 weeks, respectively.

Although in the static or passive stretching technique the elongation of the stretched muscles is maintained constantly throughout the extremity [43-45], in the present study the extremity was not maintained constant, but the elongation of the antagonist muscles was kept with very gentle efforts, throughout the 18 sec (9 sec in the first, plus 9 sec in the second cycle). When performing a static stretch on the joint end-point a practitioner tends to feel less tension while, due to changes in the viscosity of the connective tissue he/she can increase the muscle length again, until the moment when the original tension is felt [26]. Maintaining joint stability at the end position throughout the static stretch is deemed important for avoiding spindle muscle irritation and allowing agonist contraction inhibition and relaxation of the competing muscles, which can lead to short-term flexibility increases immediately after stretching bout [39]. However, Taylor, Dalton, Seaber, and Garrett [46] have raised concerns on whether this actually leads to flexibility improvements. In their opinion, increasing muscle length with static stretching stimulates the viscoelastic properties of the muscle tendon unit, rather than the effects of a mechanoreceptor mediated reflex inhibition. Magnusson et al. [33] also agree to the aforementioned concept. However, according to Garrett, Califf, and Bassett [47], immediate lengthening gained from stretching is mostly temporary and can be accredited to the induced transitory sarcomeric lengthening (actin/myosin complex relaxation).

The present findings suggest that when performing hatha yoga asanas, in the static end position, improvements in muscle length are observed when the elongation is performed gently, throughout the stretch. However, more research is required to clearly determine the acute effect of hatha yoga exercises on the joint ROM of athletes at different levels competence, as well as among untrained individuals of various age groups.

Nevertheless, it is acknowledged that while at resting state, within the myofibril sarcomere, a certain proportion of myosin cross-bridges is connected to actin [48,49]. According to Zakas, Doganis, Zakas, and Vergou [50], the temporary increase in muscle length after static extension seems to be related to muscle elongation via the disconnection of myosin cross-bridges from actin, and not via the duration of stretching time. Thus, when a muscle is elongated (either statically or dynamically), a certain proportion of myosin cross-bridges is being disconnected from actin, resulting to an increase in muscle length, and consequently ROM improvement.

In the present study, the final extreme position of each stretch was applied with continuous, mild dynamic elongation, in 6 muscle groups, for as little as 2x9 sec in total and, to the best of our knowledge, this must be the only study with such a short duration of hatha yoga asana extension in the literature. It is known that increasing the length of the stretched muscles requires a prolonged muscle extension duration in order to activate the viscoelastic properties of the elastic units of the muscles, which are deemed responsible for the joint flexibility [39,51]. Van der Poel [52] suggested that muscle length is completely dependent on how the muscle is used during movement. The data collected in the present study however, cannot suggest a specific mechanism explaining the results. Nevertheless, it is accepted [4] that during stretching, joint flexibility is affected due to the extensibility of the connective tissue relative to the amount and the duration of the force applied. For immediate effects [26], stretching increases joint ROM due to both a decrease in viscoelasticity and an subsequent increase in stretch tolerance. On the other hand, Hutton [5] proposed that the impact of the connective tissue as a stimulus for stretching appears to be overestimated, whereas the myogenic constraints in determining ROM are underestimated in the literature. Indisputably however, further studies are needed to determine the exact mechanisms responsible for improving ROM in acute stretching conditions.

5. CONCLUSIONS

The present findings collectively indicate that when performing hatha yoga asanas, stretching at the static end position forms as a stimulus, improving muscle length when performed gently, and in a dynamic manner. Moreover, athletes and soccer players in particular tend to incorporate stretching on their everyday training program and usually try to limit stretching time in favor of more technique training. Hence, taking our findings into account, coaches and athletes may reconsider whether a shorter stretching duration, without any repetitions is efficient in improving joint ROM as a basic factors for a positive outcome.

6. CONFLICT OF INTEREST

Authors state no conflict of interest.

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