Original Article

Impact of 10-weeks of yoga practice on flexibility and balance of college athletes

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ABSTRACT

Background: With clearer evidence of its benefits, coaches, and athletes may better see that yoga has a role in optimizing performance.

Aims: To determine the impact of yoga on male college athletes (N = 26).

Methods: Over a 10-week period, a yoga group (YG) of athletes (n = 14) took part in biweekly yoga sessions; while a nonyoga group (NYG) of athletes (n = 12) took part in no additional yoga activity. Performance measures were obtained immediately before and after this period. Measurements of flexibility and balance, included: Sit-reach (SR), shoulder flexibility (SF), and stork stand (SS); dynamic measurements consisted of joint angles (JA) measured during the performance of three distinct yoga positions (downward dog [DD]; right foot lunge [RFL]; chair [C]).

Results: Significant gains were observed in the YG for flexibility (SR, P = 0.01; SF, P = 0.03), and balance (SS, P = 0.05). No significant differences were observed in the NYG for flexibility and balance. Significantly, greater JA were observed in the YG for: RFL (dorsiflexion, l-ankle; P = 0.04), DD (extension, r-knee, P = 0.04; r-hip; P = 0.01; flexion, r-shoulder; P = 0.01) and C (flexion, r-knee; P = 0.01). Significant JA differences were observed in the NYG for: DD (flexion, r-knee, P = 0.01: r-hip, P = 0.05; r-shoulder, P = 0.03) and C (flexion r-knee, P = 0.01; extension, r-shoulder; P = 0.05). A between group comparison revealed the significant differences for: RFL (l-ankle; P = 0.01), DD (r-knee, P = 0.01; r-hip; P = 0.01), and C (r-shoulder, P = 0.02).

Conclusions: Results suggest that a regular yoga practice may increase the flexibility and balance as well as whole body measures of male college athletes and therefore, may enhance athletic performances that require these characteristics.

Key words: Athletes; performance; training.

INTRODUCTION

With clearer evidence of its benefits, coaches, and athletes may better see that yoga has a role in optimizing performance. The aim of this study was to determine the impact of yoga on male college athletes.

Practicing yoga has been associated with many positive outcomes in various aspects of physical performance and well-being.[1,2] The positive health outcomes that have been observed include a decrease in blood pressure,[3,4] a decrease blood lipid values,[5] a decrease in body mass index,[4] as well as an improvement in pulmonary function.[6,7] From a performance standpoint, yoga has been reported to enhance muscle torque,[8] increase in handgrip strength,[9] decrease low back pain,[10] delay the onset of muscle soreness following strenuous

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activity,[11] increase flexibility and balance[12] as well as improved cardiovascular performance.[13] The impact of yoga has also been linked to improvements in mental health. Such positive influences include reductions in anxiety,[14] depression reduction,[4,15] enhanced the state of relaxation,[16] and enhanced motivation.[17]

In addition to these, there may be direct benefits to improve the attributes commonly linked to athletic performance.[18] With clearer evidence and a better understanding of its impact on movement performance yoga could become an important component of a comprehensive training regime alongside or even replacing those of traditional exercises.[19]

The premise of yoga differs from specific types of training because of its multifaceted requirements that challenge the body in varied ways.[20,21] When done properly, athletes can optimize the body functioning by maximizing the movement affordances and minimizing the movement constraints. The physical practice of yoga, consists of maintaining regular and steady breathing while changing the positioning of the body through a series of *Asanas* (static postures) during which all the targeted and supporting muscle groups are engaged (under tension). Connecting breathing mechanics to an engaged musculoskeletal system while performing the poses provides a holistic challenge to the whole body. For example, when adopting a Warrior 2 (standing lunge) position an upright torso is twisted inward and the hips and head are twisted in the opposite direction; with emphasis on the muscular effort of the arms and legs. The arms are aligned with the shoulders and are stretched outward as far as possible while hyperextending and internally rotating the trailing leg. During these movements, the timing and duration of each breath are regulated to coincide with the duration of each pose as well as with the initiation of transitions between each pose.[22]

Traditional athletic training utilizes specific activities to improve the specific domains of fitness. For example, repeated periods of long-distance running will challenge the cardiovascular system and therefore, increase the cardiovascular fitness. Regular weight lifting challenges the contractile capacity of specific muscular groups and will increase the muscular strength. Traditional training, therefore, is done to enhance the components of fitness that contribute to a given sports performance.[23] Thus, athletic performance is believed to be improved as performance in the components of fitness related to that sport improves. Although such training maximizes the specific components of fitness, difficulties occur in utilizing these specific fitness gains to enhance athletic performance.[24]

One approach to utilize specific fitness gains is to structure training exercises so that they very closely relate to the movements of that sport. For example, training using the leg extension lifts are often used because they closely resemble a soccer kick. Repeatedly rehearsing the actual soccer kick (kicking drills) following a session of heavy weight lifting could also accomplish the same thing.[24,25] Despite improvements in the muscular endurance of a soccer kick as a result of training, evidence that these gains have contributed to athletic performance is difficult to see.

In contrast, yoga is an activity that can simultaneously enhance several specific components of fitness. For instance, following weeks of practice, joints comprising movement in their kinetic chains may be optimized through increased alignment, increased range of motion, and a greater muscle fibers recruitment.[26-28] This more optimal performance occurs as flexibility increases and muscle tension reduces thereby producing a greater stretching effect on the surrounding connective tissue to ultimately "loosen" it, thus, reducing the load placed on the ligaments and joints.[22,27] In this way, new movement options become possible as connective tissues become laxer, muscles become more active, and joints move more freely.[29]

Because of its multifaceted emphasis, yoga is a highly structured activity that mimics critical aspects of athletic performance including balance, flexibly, muscular strength, muscle endurance, and movement efficiency (coordination).[26,30] As such, practicing yoga may have a uniquely positive and varied impact on athletic performance.[31] For instance, successful soccer players must continually move their body in one of a variety of different directions while simultaneously maintaining the balance and extend joints beyond a normal range of motion. Similarly, an evolved yoga session maximizes the balance and joint range of motion by consciously transitioning the body through a series of constraining positions as fluidly and efficiently as possible.

The purpose of this paper, therefore, is to investigate if and how yoga can impact specific components of fitness related to athletic performance. Thus, through a greater enhancement of components of fitness performance the capacity for athletic performance should increase. In order to enhance the application of our results to competitive situations, we performed our experiment on college athletes who already were well trained for their athletic events.

Hypothesis

We hypothesized that the regular practice of yoga positioning training for 10 weeks in college athletes would enhance the measures of balance, flexibility, and joint angles (JA) measures.

METHODS

In this 10-week preliminary study, pre-post measures in a quasi-experimental design were done to assess the impact of yoga on specific aspects of athletic fitness. Two independent groups engaged in separate athletic pursuits were used. Recruitment of participants occurred through the availability of college coaches allowing the researchers to collect the data on their athletes. Participants (N = 26) were Division II male athletes, who attended a medium-sized Midwestern University during a fall term. The subjects were members of either the soccer team (n = 14) or the baseball team (n = 12). The participants had no extensive prior experience with yoga and were free from injury. They completed a medical history questionnaire and signed consent forms prior to being cleared to participate in the study and were naive to the purpose of the study. The university institutional review board approved all the experimental procedures prior to data collection.

Procedures

The yoga group (YG) was comprised soccer team players (mean age = 19.8 years, s = 1.05) while the nonyoga group (NYG) was comprised baseball team players (mean age = 20.3 years, s = 1.06). During the same 10-week period, members of both groups completed the regularly scheduled sport specific training sessions. While much of the training for the two sports was mutually exclusive, common activities included static stretching exercises, weight training, and running. In addition to their regular training, the YG subjects took part in certified instructor-led yoga sessions 2 mornings (Tuesday and Thursday) each week before any other physical activity. During the hour-long sessions, the instructor demonstrated the series of yoga postures that were then mimicked by the subjects. Subjects in both groups were asked to not participate in any additional training activities. Measures of flexibility, balance, and JA were taken immediately before and shortly after the 10-week study.

Measures

Because both flexibility and balance are the essential components of many sporting activities, we chose these to provide a quantifiable examination of how yoga may contribute to enhancing of performance.[12,32,33] In addition to these measures, we also measured the whole body positioning to demonstrate the changes in various JA.[34] JA measures were used to describe the kinetic chains performed during various yoga positions. Together, such values should demonstrate that practicing yoga enhances the performance of specific components of fitness and potentially explain how yoga may afford such changes.

Assessments for each group were completed separately. Two days prior to the first yoga session the assessment protocol was completed for the YG; the following day the same testing protocol was completed for the NYG. One day, after the 10-week yoga sessions, the testing protocol was repeated with the YG athletes and another day later with the NYG athletes. Without prior warm up, the following assessment protocol was completed: (1) Shoulder flexibility (SF), (2) Sit-reach (SR), (3) Stork stand (SS), (4) right forward lunge (RFL), (5) downward dog (DD), and (6) chair.

The measures of flexibility were determined by an SF test[23] and SR,[33] while a test of balance was conducted with a stork stand (SS) test.[35] The best of three attempts was recorded. Subjects were video recorded for assessing: Right forward lunge (RFL), DD, and chair [Figure 1]. This assessment consisted of determining the maximal JA for ankle, knee, hip and shoulder joints attained during each position.[34,36] During this assessment, the participants were instructed to stand on their right side toward the camera and hold each of the three positions for 10–15 s. Analyzes of the video recordings were completed using Dartfish tracking software. For unilateral joint positioning angles such as the position adopted during a lunge, both the right and left JA were determined. For bilateral positioning such as the position adopted during DD and chair, only the right JA were measured.

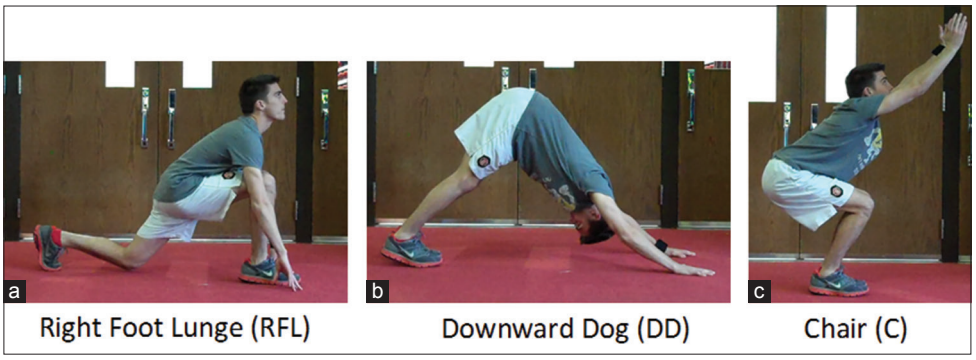

Figure 1: (a-c) Positions for holistic measure of joint angles

Descriptive and inferential statistical analyzes were completed for both flexibility and balance and whole body measures. The availability of subjects from two separate sports restricted between group comparisons and thus within group comparisons were emphasized. Pre-post comparisons of means were calculated for all measured values. Change scores ($\alpha = 0.05$) were analyzed using paired *t*-test and Welch's two-sample *t*-test.

RESULTS

Flexibility and balance

Gains in flexibility (SR and SF) and balance (SS) were observed in the YG over the 10-week period [Table 1]. SR [Figure 2] performance had a mean increase from 21.4 inches (standard deviation [SD] = 3.9) to 23.1 inches (SD = 2.5) with difference of 1.8 inches and SF [Figure 3] had a mean increase from −0.1 inches (SD = 3.1) to 0.7 inches (SD = 2.9) with a difference of 0.7 inches. Stork stance time [Figure 4] for this group also had a mean increase from 12.5 s (SD = 6.5) to 16.5 s (SD = 8.3) with a difference of 4.0 s.

In contrast to the changes in the YG, the NYG declined in both flexibility and balance [Table 1]. SR [Figure 2] mean performance decreased from 21.4 inches (SD = 2.7) to 21.0 inches (SD = 3.6) with a difference of −0.4 inches and SF [Figure 3] had a mean decreased from −1.1 inches (SD = 3.8) to −2.1 inches (SD = 2.9) with a difference of −1.0 inch. Stork stance [Figure 4] time for this group also had a mean decrease from 22.7 s (SD = 8.8) to 18.6 s (SD = 9.6) with a difference of −4.1 s.

A within group *t*-test comparison of these measures revealed the significant gains in performance for the YG subjects in SR ($P = 0.01$), SF ($P = 0.03$), and SS ($P = 0.03$). No significant differences within the group for the NYG subjects were observed. In addition, between group (YG-NYG) comparisons revealed the significant differences (*) in SR ($P = 0.04$) and SS ($P = 0.04$) at the end of the 10-week training period [Table 1].

Whole body measures

A within group comparison of pre-post JA difference was completed for each of the 3 positions [Tables 2 and 3]. An illustration of the pose and direction of these significant JA changes for the YG can be seen in Figure 5. Significant differences during the RFL included a mean increase of −6.6° (SD = 11.3) in dorsiflexion ($P = 0.04$). Significant differences in the DD position consisted of a mean increase in knee extension ($P = 0.04$) of + 3.7° (SD = 6.4), a mean increase in hip extension ($P = 0.01$) of + 10.7° (SD = 13.1) and a mean increase in shoulder flexion ($P = 0.01$) of −7.87° (SD = 8.8). Significant changes observed during the chair position consisted of a mean increase in knee flexion ($P = 0.01$) of + 12.9° (SD = 8.6).

Table 1: YG and NYG traditional measures

Group	Measure	Sit reach (inches)	Shoulder flexibility (inches)	Stork stand (seconds)
YG	Change	Increase	Increase	Increase
	Difference	1.8	−1.0	4
	P value	0.01*	0.03*	0.03*
NYG	Change	Decrease	Decrease	Decrease
	Difference	−0.4	−1.0	−4.1
	P value	0.22	0.18	0.11
YG-NYG	*P* value	0.04*	0.14	0.04*

YG=Yoga group; NYG=Nonyoga group

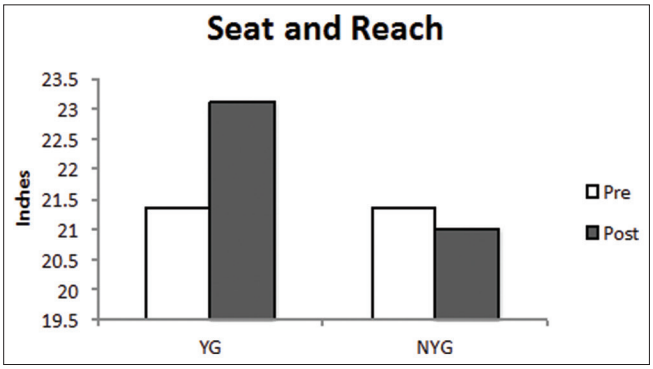

Figure 2: Pre-post seat and reach averages (inches) for yoga group and nonyoga group

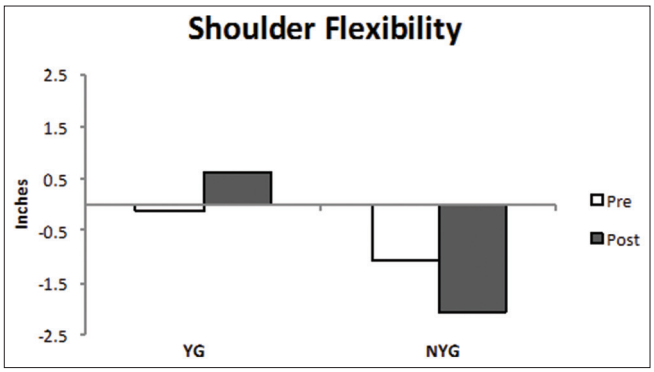

Figure 3: Pre-post should flexibility averages (inches) for yoga group and nonyoga group

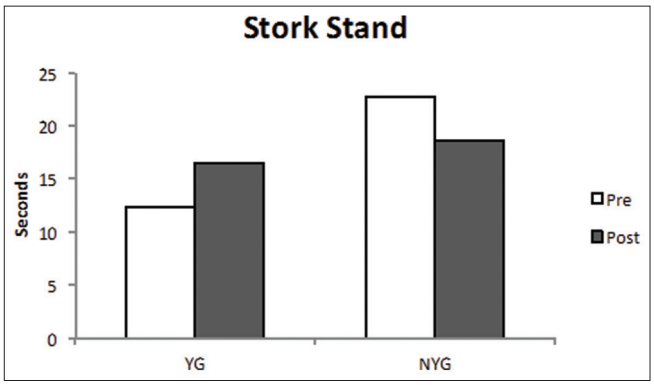

Figure 4: Pre-post stork stands averages (seconds) for yoga group and nonyoga group

Significant differences (*) observed in the NYG subjects occurred in the DD and the chair positions. An illustration of the pose and direction of these significant JA changes for the NYG can be seen in Figure 6. Observed differences for the DD position included a mean increase in knee flexion ($P = 0.01$) of − 11.44° (SD = 11.6), a mean increase in hip flexion ($P = 0.05$) of − 11.2° (SD = 17.9) and a mean increase in shoulder flexion ($P = 0.03$) of −15.8° (SD = 22.2). Changes in the chair position consisted of a mean increase in knee flexion ($P = 0.01$) of −9.06° (SD = 9.4) and a mean increase in shoulder extension ($P = 0.05$) of + 6.14° (SD = 9.5) [Table 3].

Differences [Table 4] were also observed between the groups in the RFL [Figure 7], DD [Figure 8] and chair [Figure 9] positions. A comparison of JA during the RFL revealed a mean difference ($P = 0.01$) in the left ankle of 9.4°. Mean JA differences in the DD position of 15.1° were found in the right knee ($P = 0.01$) and 21.9° in the right hip ($P = 0.01$). Mean differences between YG and NYG subjects during the chair pose were observed for the right shoulder ($P = 0.02$) of 11.7°.

The findings for both flexibility and balance measures as well as whole body measures illustrate the significant positive changes due to the participation in yoga training in the YG as well as the significant differences between YG and NYG subjects.

DISCUSSION

In this preliminary study, all athletes took part in their regular training programs. Typical sessions included flexibility exercises as part of their regular warm up

Table 2: Summary of YG joint angles

Position	Joint	Diff	Movement	*T* test (*P* value)
R-foot lunge	Right knee	−5.04	Flexion	0.13
R-foot lunge	Right hip	−1.13	Flexion	0.51
R-foot lunge	Right shoulder	3.92	Extension	0.27
R-foot lunge	Left knee	−2.69	Flexion	0.56
R-foot lunge	Left ankle	−6.57	Dorsiflexion	0.04*
Downward dog	Right ankle	−1.58	Dorsiflexion	0.50
Downward dog	Right knee	3.70	Extension	0.04*
Downward dog	Right hip	10.70	Extension	0.01*
Downward dog	Right shoulder	−7.87	Flexion	0.01*
Chair	Right ankle	−5.35	Dorsiflexion	0.10
Chair	Right knee	−12.85	Flexion	0.01*
Chair	Right hip	−1.92	Flexion	0.46
Chair	Right shoulder	−5.57	Flexion	0.21

YG=Yoga group

Table 3: Summary of significant NYG joint angles difference

Position	Joint	Diff	Movement	*T* test (*P* value)
R-foot lunge	Right knee	−2.54	Flexion	0.64
R-foot lunge	Right hip	−1.04	Flexion	0.73
R-foot lunge	Right shoulder	9.27	Extension	0.20
R-foot lunge	Left knee	−6.04	Flexion	0.25
R-foot lunge	Left ankle	2.83	Plantar flexion	0.32
Downward dog	Right ankle	−0.41	Dorsiflexion	0.93
Downward dog	Right knee	−11.44	Flexion	0.01*
Downward dog	Right hip	−11.20	Flexion	0.05*
Downward dog	Right shoulder	−15.80	Flexion	0.03*
Chair	Right ankle	−3.39	Dorsiflexion	0.10
Chair	Right knee	−9.06	Flexion	0.01*
Chair	Right hip	−7.43	Flexion	0.07
Chair	Right shoulder	6.14	Extension	0.05*

NYG=Nonyoga group

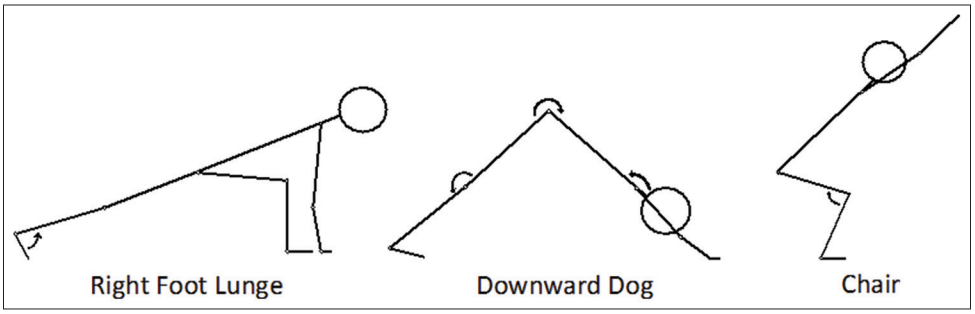

Figure 5: Yoga group significant joint angle changes

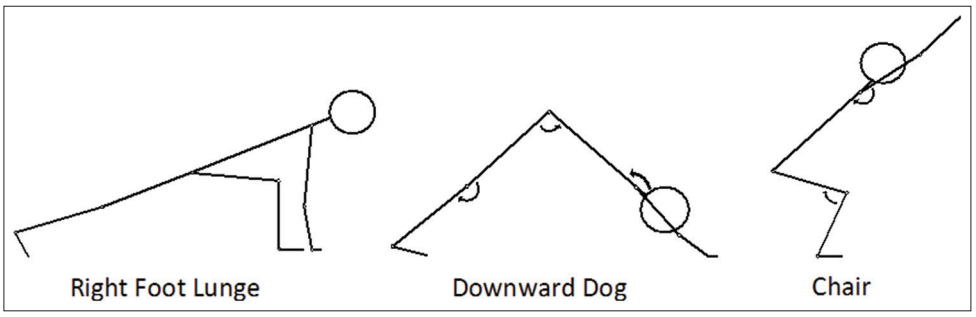

Figure 6: Non yoga group significant joint angle changes

Table 4: Summary YG and NYG joint angles difference

Position	Joint	Difference (degrees)	Between (YG-NYG) *T* test (*P* value)
R-foot lunge	Right knee	2.50	0.34
R-foot lunge	Right hip	0.09	0.49
R-foot lunge	Right shoulder	5.35	0.25
R-foot lunge	Left knee	3.36	0.31
R-foot lunge	Left ankle	9.40	0.01*
Downward dog	Right ankle	1.17	0.41
Downward dog	Right knee	15.14	0.01*
Downward dog	Right hip	21.90	0.01*
Downward dog	Right shoulder	7.93	0.13
Chair	Right ankle	1.96	0.29
Chair	Right knee	3.80	0.15
Chair	Right hip	5.51	0.12
Chair	Right shoulder	11.72	0.02*

YG=Yoga group; NYG=Nonyoga group

routine, strength training, skill-specific drills, as well as participating in the sport itself (both in competition and in regular practice). In the YG, additional yoga training was provided. Both flexibility training and yoga are known to enhance the range of motion of joint systems[37,38] in comparison to no training. Because all the athletes participated in stretching exercises as part of their warm ups, we expected that both groups would improve in flexibility tests.

Our results indicate for the 1st time that when added to the traditional flexibility exercises, yoga training significantly enhances the measures of flexibility. In contrast, the NYG had no improvement and in some cases, the flexibility declined. The YG subjects also had greater flexibility than the members of the NYG. Thus, 10 weeks of practicing yoga enhanced the flexibility in the actively training athletes while warm up stretching did not: A result that may have important implications for sports training.

Because their regular practice of training activities (free weight training and practicing sport skills) challenged stability and balance, we expected that improvements in balance[39] would be observed in both the YG and NYG athletes. In addition, because yoga practice has been shown to enhance the balance.[12,39] we expected that the inclusion of a regular yoga practice would further enhance the balance. As expected, the YG athletes improved in balance however the NYG athletes did not. The impact of yoga was further demonstrated with significantly better balance for YG versus NYG. These findings suggest that the additional 10-weeks of yoga practice to a regular training routine has a positive impact on balance.

Logically, training that emphasizes the multiple components of fitness at once should more readily enhance movement performance.[31,40] As all of the athletes took part in varied and multi-dimensional training, we expected that the improvements would have occurred in a whole body measure. Using the right foot lunge, the YG

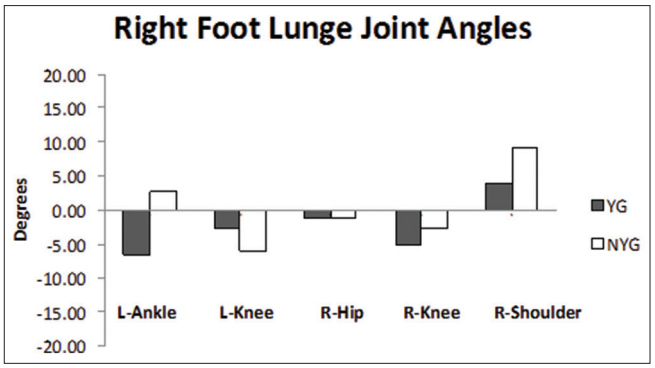

Figure 7: Average joint angle difference (degrees) in right foot lunge - yoga group and nonyoga group

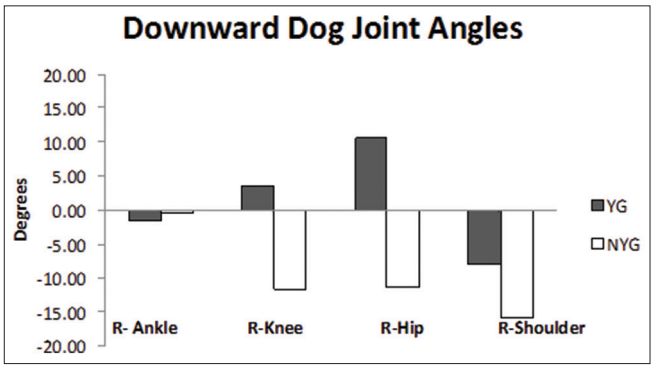

Figure 8: Average joint angle difference (degrees) in downward dog - yoga group and nonyoga group

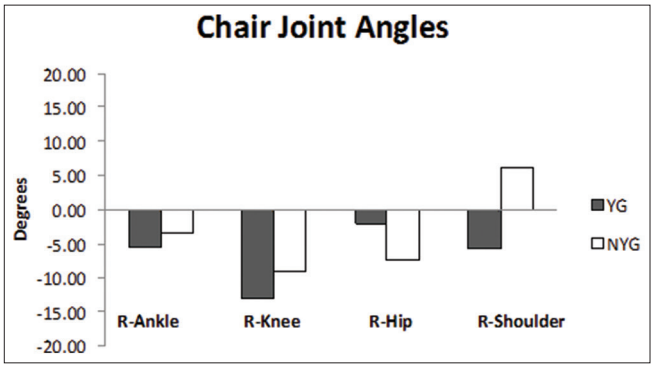

Figure 9: Average joint angle difference (degrees) in chair for yoga group and nonyoga group

athletes displayed greater dorsiflexion of the ankle during RFL, while no significant changes were observed for the NYG athletes. A between groups comparison for the RFL indicates that the YG athletes utilized more dorsiflexion of left ankle position while the NYG athletes adopted a more plantar flexed position. These variations are suggestive that YG athletes are better able to balance their body weight and eccentrically stretch their posterior shank muscles than NYG athletes.

In the DD position, the NYG athletes had significantly greater knee flexion, hip flexion, and shoulder extension. Thus, their hips were lowered, and their weight shifted

away from the upper body. These changes indicate the tightness in the hamstrings and the lower back muscles. The YG athletes increased the knee extension and hip extension, coupled with greater shoulder flexion. Thus, the YG athletes were better able to simultaneously lengthen hamstring and lower back muscles and maintain a flexed shoulder during the DD. Overall, the NYG athletes may have poorer hamstring and lower back flexibility while athletes in the YG may be better able to eccentrically load the hamstring and lower back muscles.

Joint changes observed during the chair position suggest that athletes in both the YG and NYG exhibited greater knee flexion. For the NYG athletes, this shift was coupled with an increased shoulder extension. Such positioning occurs as the arms are lowered to provide a counter balance and a more flexed knee position then becomes possible. In contrast, the YG athletes maintained shoulder positioning while simultaneously displaying a greater bend in the knee, thus, displaying a more active and balanced positioning. These variations are suggestive that NYG athletes are able to flex their knees by counter balancing their body weight about their center of mass; with a more flexed shoulder positioning, the YG athletes can maintain balance through a more engaged lower body.

CONCLUSION

The intended purpose of this quasi-experiment was to emphasize the impact yoga may have on specific components of fitness on athletes. In support of this view, the athletes who practiced yoga for 10 weeks demonstrated the improvement in both flexibility and balance measures. Based on previous findings, it would be expected that YG athletes would consistently outperformed the NYG athletes in flexibility and balance. One potential explanation for the improvement in these measures may be found from changes in whole body measures. Increases in JA values may indicate a more optimal kinetic chain that may allow for enhanced flexibility and balance. In addition, both study groups took part in their specific sport training activities intended to maximize the specific aspects of athletic performance. However, emphasis on a particular component of fitness may compromise other aspects of fitness. For example, an athlete who lifts heavy loads during upper body exercises may experience gains in maximum upper body strength as well as a reduction in SF.[40] In this view, the specialized sports training associated with the NYG may explain the loss of flexibility and balance. In contrast, taking part in an additional activity that emphasized multiple components of fitness, may explain the enhanced measures of flexibility and balance for the YG athletes.

To maximize the training opportunities, activities that more effectively improve athletic performance are critical. Because sport is a multi-dimensional endeavor, athletes may consider taking part in activities that optimize the specific dimensions of fitness as well as the aspects of the multiple dimension of performance.[40]

Our findings suggest that the practice of yoga as part of traditional training methods enhances the components of fitness that are the essential components of sports performance. Thus, the practice of yoga may provide an additional training option to enhance performance. Future studies in this area should explore the impact of yoga training on specific components of fitness in relation to sport specific tasks or compare group athletes from the same sport. In this way, it may be possible to demonstrate the impact of yoga on sports performance.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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