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RESEARCH ARTICLE

EFFECTS OF YOGA TRAINING ON BILATERAL STRENGHT AND SHOULDER AND HIP RANGE OF MOTION

Munoru Pauline and Elijah Gitonga Rintaugu

Department of P.E and Sports, University of Nairobi, Nairobi, Kenya

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ABSTRACT

In recent years, the practice of yoga has gained widespread popularity within the health and fitness industry. The practice of yoga is said to improve physical fitness and the main objective of this study was to evaluate the effects of a 12 week yoga intervention on shoulder and hip range of motion(ROM) and to compare the strength differences between the left and the right sides of the leg, chest, shoulder muscles before and after its intervention. 21 female subjects (age 34.62±9.866) took part in the study with 12 subjects being the control group and 9 the experimental group. Range of motion measurements and I-RM strengths tests were carried out before and after intervention. There was an overall significant difference found on shoulder flexion, hip flexion and extension and hip abduction ($p<0.05$). There was an increase in range of motion for these movements, muscular strengths for each side of the leg and chest muscles. Bilateral strengths for each side showed no significant changes ($p<0.05$). It was concluded that a12 week yoga training practice created improvements in shoulder flexion, hip flexion, hip extension and abduction range of motion.

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***Corresponding author:** elijahgitonga2001@yahoo.com

INTRODUCTION

Flexibility is a term that describes the range of movement or motion (ROM) of simple or multiple joints and reflects the ability of muscle tendon units to elongate within the physical restriction of joints (MacDougall, Wenger and Green, 1991, Holland, Kiyoji, Ryosuke and Nakagaichi, 2002). Flexibility is of interest to coaches, physical educators and sport scientists because of its importance for athletic performance, injury prevention and rehabilitation (MacDougall, *et al,* 1991). Stretching to improve flexibility is considered an effective method of preventing injuries modes, ligaments and tendons. Stretching has also positive effects on precaution against developing short muscles, hardening of muscular resting tension and prevention of muscle tightness, increase of joints range of motion, prophylaxis against injuries and due to these stretching effects there is a general increase in muscular performance (Sady, Wortman, and Blance, 1982., Corbin, 1984., Madding, Wong, Hallum andMedievos 1987, Worrel, Smith and Winegardner, 1994). A regular practice of yoga is theoretically thought to improve flexibility and muscular strengths in adults without any known pathology. For practice there are some simple postures that may be used by beginners that with time improve flexibility, strength and endurance (Sequiera, 1999). Birch (1995) states that muscle imbalance which may have developed from poor posture, an old injury or from the uneven use of one side of the body often makes its presence known through yoga training.

Although yoga is said improve physical fitness outcomes, the evidence seems to be surprisingly scarce and overwhelmingly inconclusive. Despite the popular perception that yoga is exercise (Horrigan, 2004) much of the research involving yoga has focused on illness or disease related outcomes (Raub, 2002). Thus the purpose of the study was to determine the effect of a12 week haltha yoga therapy intervention on hip and shoulder range of motion i.e. flexion, extension, abduction and adduction in healthy females with no musculoskeletal disorders and had never participated in yoga program for at least a year before the study. The study was out to determine whether there will be changes in muscular strengths of the left and right sides of the quadriceps, chest and shoulder muscles.

Review of literature

The range of motion (ROM) of any joint is limited by skeletal, muscle and periarticular or surrounding connective tissue functions (Alter,1996) and is also influenced by multidimensional factors throughout the lifespan, including gender, heredity, environment, neural mechanism and residual muscle tension (Holland *etal*, 2002). Women tend to generally have more extensive ROM in the major joints as compared to men. This is because they have a different pattern of skeletal architecture and connective tissue morphology as well as hormonal differences (Gabbardand Tamudy, 1988). Research assessing a variety of outcomes and different aspects of yoga has indicated that yoga can promote positive physical changes. Research indicates that Yoga Asanas can be effective in managing symptoms associated with musculoskeletal disorders including osteoarthritis, carpal tunnel syndrome, hyperlyphosis and low back pain (Gartinkel *etal* 2002, Greendale *etal*, 2002 and Galantino, Bzdewke, Eissler-Russo, 2002). Regular practice of haltha yoga 2 times a week for 8 weeks has been shown to improve upper and lower extremity torques measured with an isokinetic device at speeds of 30^0 per second and 60^0 per second increased the ability to hold a lower extremity isometric impaction as well as improvement in shoulder, ankle and optimal flexibility (Bastille and Gill-body, 2004). Gartinkel, *etal*, (1998) examined eleven yoga postures for the arm, each held for 30seconds along with relaxation. After 8 weeks, grip strength was significantly better and there was a trend to improvement in motor and sensory nerve conduction in both controls and the yoga treated group but the difference between the pre-treatment and post-treatment findings was not significant. Boyle *et al* (2004) assessed whether yoga pain would attenuate the intensity of muscle soreness after strenuous exercise and whether soreness would be reduced with a single bout of yoga when muscle soreness is elevated. The study found that yoga trained individuals experienced less soreness after eccentric exercise than non-yoga trained individuals resulting from greater flexibility.

Williams *etal* (2005) carried out a study on the effect of yoga therapy for chronic back pain. It was posited that Iyengar yoga therapy would progressively rehabilitate lower back pain by addressing imbalances in the musculoskeletal system that affect spinal alignment and posture. The results of the study supported the hypothesis that yoga therapy confers greater benefits to chronic lower back pain patients. Results from this study will add knowledge on the physiological benefits of yoga therapy on healthy subjects as compared to previous research which mainly tested subjects with clinical ailments or those that had musculoskeletal injuries.

MATERIALS AND METHODS

Subjects: 21 female subjects from local fitness centers in the Wands worth area of South West London volunteered to participate in the study. The control group consisted of 12 females while the experimental group initially had 12 females but 3 withdrew from this study due to illness. Anthropometric measurements of the subjects were age (34.62±9.866 years), weight of 58.29±4.41 and height 1.69±0.054). All subjects were healthy individuals who had never participated in a yoga exercise program for at least a year prior to the study and who had no musculoskeletal dysfunction or other contraindications to exercise. Each subject read and signed an informed consent form before the study.

Instruments: The experimental group had to attend yoga training program for 2 sessions a week and each session was an hour and a half in duration. The sessions included review of basic philosophy including concentration, mediation and withdrawal of the senses. The participants were instructed to participate to their own level of ability, modify the postures needed and rest if necessary. Testing was carried out before and after completion of the 12 week yoga training program.

Measurements: Universal true-angle goniometer was used to measure range of motion and three readings were recorded for each movement (Norkin and White, 1988). Measurements were taken for shoulder flexion and extension, shoulder abduction and adduction, hip flexion and extension, and hip abduction and adduction. All subjects underwent a bilateral strength testing of the upper and lower body on a life fitness FZCP chest press machine, a life fitness shoulder press machine and life fitness FZSLP seated leg press machine. Steps for carrying out an IRM test were obtained from Hayward (2002). Prior to testing each subject warmed up and familiarized themselves with the equipment by completing 5 to 10 repetitions of the exercise at 40% to 60% of the perceived maximum. After a minute rest with light stretching of the shoulder, chest, hamstring and quadriceps muscles three to five repetitions of the exercise at 60% to 80% of the estimated IRM followed. The chest press and shoulder press machine measured the strength of the large muscle groups of the upper body and the leg press measured strength of the quadriceps muscles.

Data analysis: The statistical analysis included the computation of descriptive statistics for each anthropometric measurement on each variable. Paired sample *t*- tests were used when necessary to determine where the significant differences within groups occurred. An independent t-test was used to determine where the significant differences between the groups occurred and statistical significance was set at a probability level of $p<.05$.

RESULTS AND DISCUSSION

Mean ROM values for all subjects are reported in Table I below while mean values for each separate group is shown in Table 2.

Flexibility results: The results of flexibility tests in Table 1 and 2 are presented below, under shoulder and hip range of motion.

Shoulder range of motion: There was an overall significant effect on time in shoulder flexion ($df=1$, $F=354.38$, $p<0.001$ and also a significant difference between the two groups on shoulder flexion. After a pained t-test, the before and after means for each side were significant (right shoulder flexion, $t=3.725$, $df=20$, $p<0.05$), left shoulder flexion $t=3.806$, $df=20$, $p<0.05$) .For shoulder extension the only significant present was between the two groups ($df=1$, $F=4.758$, $p<0.05$). No significant change occurred on shoulder abduction and adduction.

Hip range of motion: For hip flexion there was a main effect of time and the interaction between time and group ($df=1$, $F=6.5$, $p<0.05$) hip extension ($df=1$, $F=694.85$ $p<0.001$) and hip abduction ($df=1$, $F=67.85$, $p<0.001$). However there were no significant changes which occurred on hip adduction, increases in range of motion only on occurred in flexion, extension and abduction. Paired sample *t*-tests showed significance on only the right side of the mix before and after the intervention ($t=3.74$, $df=20$, $p<0.05$) but not on the left hip joint. Secondly, after paired sample tests for both left and right sides, significance occurred as an effect of time (right hip extension $t=3.740$, $df=20$, $p<0.05$, left hip extensions $t=3.749$, $df=20$, $p<0.05$ and significance was present as an effect of df=20, p<0.05) (left hip abduction, t=3.162, df=20, p<.05).The

Table 1: Mean range of motion for all subjects

ROM	Before x and SD	After x and SD
Right shoulder flexion	168.10±1.895	170.00±3.146
Left shoulder flexion	168.00±1.871	170.00±3.146
Right shoulder extension	53.19±2.159	53.19±2.159
Left shoulder extension	53.33±1.798	53.33±1.798
Right shoulder abduction	165.33±3.979	165.33±3.979
Left shoulder abduction	165.57±3.957	165.59±3.957
Right shoulder abduction	165.33±3.979	165.33±3.979
Left shoulder abduction	165.57±3.957	165.57±3.957
Right hip flexion	121.00±9.192	122.19±8.322
Left hip flexion	122.24±8.933	122.62±8.375
Right hip extension	26.76±0.700	27.81±1.750
Left hip extension	26.76±0.700	28.00±1.844
Right hip abduction	43.81±1.537	44.57±1.502
Left hip abduction	43.1±1.401	44.48±1.289
Right hip abduction	23.57±0.746	23.62±0.740
Left hip abduction	23.67±0.796	23.71±0.784

Table 2: Group means and standard deviation (ROM)

S.No	ROM	Control group N=12	Experimental N=9
1.	Right shoulder flexion	167.92±2.151	168.33±1.581
2.	Left shoulder flexion	167.92±2.151	168.11±1.537
3.	Right shoulder extension	54.08±1.929	52.00±1.936
4.	Left shoulder extension	53.83±1.7349	52.67±1.732
5.	Right shoulder abduction	166.00±2.73	164.44±5.270
6.	Left shoulder abduction	166.00±2.539	164.44±5.270
7.	Right shoulder abduction	166.00±2.730	164.44±5.270
8.	Left shoulder abduction	166.42±2.539	164.44±5.270
9.	Right hip flexion	124.17±10.268	116.78±5.585
10.	Left hip flexion	124.67±10.138	119.00±6.124
11.	Right hip extension	26.42±0.669	27.22±0.441
12.	Left hip extension	26.50±0.674	27.11±0.601
13.	Right hip abduction	44.25±1.765	43.22±0.972
14.	Left hip abduction	44.17±1.403	43.33±1.323
15.	Right hip adduction	23.58±0.793	23.56±0.726
16.	Left hip adduction	23.75±0.866	23.56±0.726
17.	After right shoulder flexion	167.92±2.151	172.78±1.781
18.	After left shoulder flexion	167.92±2.151	172.78±1.787
19.	After right shoulder extension	54.08±1.929	52.00±1.936
20.	After left shoulder extension	53.08±1.749	52.67±1.732
21.	After right shoulder abduction	166.00±2.730	164.44±5.270
22.	After left shoulder abduction	166.42±2.539	166.44±5.27
23.	After right shoulder adduction	166.00±2.730	164.44±5.27
24.	After left shoulder adduction	166.42±2.539	164.44±5.27
25.	After right hip flexion	124.17±10.268	119.56±3.812
26.	After left hip flexion	124.67±10.138	119.89±4.4
27.	After right hip extension	26.42±0.669	29.67±.500
28.	After left hip extension	26.50±0.674	30.00±0
29.	After right hip abduction	44.25±1.765	45.00±1.00
30.	After left hip abduction	44.17±.03	44.89±1.05
31.	After right hip adduction	23.58±0.793	23.67±0.707
32.	After left hip adduction	23.75±0.866	23.67√0.707

t=2.370, df=20, p<0.05 intervention was significant.

Chest press: Effect of time (F=3.836, P<0.05) and side F=4.829, P<0.05 was significant within the subjects but not between the two groups. And the paired t-test analysis to compare the sides before (t=2.169, df=20, p<0.05) and after (t=2.169, df=20,p<0.05) intervention were significant.

Leg press: Effects of time (f=100.62, p<0.001) and side (F=12.58, p<0.001 were significant with subjects and between subjects (F=8.51, p<0.05). Paired t-test showed significance before (t=3.147, df=20, p<0.05) and after (t=3.200, df=20, p<0.05) the training sessions.

DISCUSSION

Effects of flexibility: The present study showed an increase of shoulder flexion for both the left and right shoulder joints as a result of a 12 week yoga intervention. This improvement on shoulder flexion possibly was that the posture that was used could have predominantly focused on stretching of the shoulder flexions. Hip abduction showed a significant improvement, the pose that emphasized this muscle group was the triangle pose. Since most of the subjects were dominant on the right side, there was a more significant improvement in flexion on the right hip among the experimental group when compared with the left hip. But with hip extension, increases at the left hip joint were significantly higher than the right. These results collaborate with Roberts and Wilson (1999) which showed that holding stretches for 15 seconds resulted in greater improvements in the range of motion. However this contradicts with the study results demonstrated by Borms *et al,* (1987) to determine the optional duration of static stretching exercises for the improvement of coxo-femoral flexibility. However it is noted that in this study the interacting effects of training frequency, duration, distance and intensity in prevention of running injuries were not considered (Yeung and Yeung, 2001). Bandy *et al* (1997) attempted to determine the effects of frequency of static stretching by comparing a control with different times for different groups. They reported that all groups increased hamstring lengths compared with the control but no difference was found among the different frequencies or stretching durations. However, controversy continues regarding which stretching technique is most effective and what frequency, length of program, speed of stretch and the intensity of stretch for those various techniques should be.

Table 3: Mean IRM tests for all subjects

Strength test	Before	After	df	t-ratio	Sign
Right shoulder press	12.929±3.433	12.976±3.356	20	2.37	p<0.05
Left shoulder press	11.952±2.962	12.071±2.972	20	2.73	p<0.05
Right chest press	8.571±2.803	8.833±2.662	20	2.169	p<0.05
Left chest press	7.714±2.513	7.976±2.452	20	2.003	p<0.05
Right leg press	36.262±3.747	58.595±4.918	20	1.403	p<0.05
Left leg press	33.833±4.291	36.214±5.433	30	3.147	p<0.05

mean 1-RM Test results for all the subjects are shown in Table 3.

Bilateral strength results

Shoulder press: Mixed ANOVA showed significant differences of side df=1, F=4.483, P<0.05 as well as time df=1, F=6.186, p<0.05) within the subjects. A paired *t*-test to

Muscular strength characteristics: Although the increase in shoulder muscle strength was not significant 3 subjects not of the 9 experimental group demonstrated an increase while they performed the shoulder press. For the chest press, the experimental group did increase their strengths with the right side being predominantly stronger than the left. Thus, the findings of this study were that the 12 week yoga training body muscular strength in women 24 to 38 years of age. But there was no reduction in strength asymmetry between both sides with the exception of shoulder muscles. Yoga training protocols provide a stimulus for enhancing muscle strengths through increases in motor unit activation and improvements in motor still coordination as opposed to hypertrophic factors. The chest and leg muscles on the dominant side were significantly stronger that their non-dominant side. Therefore, the yoga intervention did not reduce the bilateral strength differences between the two sides of each muscle group, but clearly caused an increase in strengths of the leg and chest muscles. This may have been as a result of the extent to which the muscle has been activated by neural factors. Freindman (1998) found that subjects had significantly greater peak to give on the asymptomatic limbs when compared to the symptomatic limbs. Rupp *et al* (1995) compared the isokinetic strengths characteristics of the shoulder on 22 competitive swimmers. A trend was noted for the right shoulder exhibiting higher peak torque that the left shoulder. Wang *et al* (2000) compared differences in strength of the shoulder muscles in the dominant and non-dominant side. They performed isokinetic tests on elite volleyball players and the findings indicated that average peak strength at 60% external eccentric contraction was lower than that of internal concentric contraction in the dominant arm but was higher in the non-dominant arm.

CONCLUSION

From the findings of the study, it is apparent that yoga therapy confers greater benefits by improving flexibility. More specifically it was demonstrated that the intervention caused a significant improvement in shoulder flexion, hip flexion and extension and hip abduction. These findings show that yoga training appears to have significant implications for coaches, athletes, clinicians and the exercising public who may want to implement yoga training as a supplemental activity in an attempt to increase strength and flexibility. However more studies with larger sample sizes and large follow-up to determine the long term effects of yoga are proposed.

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