Cantaurus, Vol. 16, 28-31, May 2008 © McPherson College Division of Science and Technology

The Effects of Yoga Conditioning for Athletes on Cardiorespiratory Endurance

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ABSTRACT

The Importance of flexibility on muscle and cardiorespiratory endurance is still unclear. The intent of this study was to determine whether an increase in flexibility would lead to an increase in cardiorespiratory endurance. Sixteen active subjects were used and split into three groups: Control Group (4 males, 4 females), Test Group #1 (2 males, 2 females), and Test Group #2 (2 males, 2 females). The Control Group went eight weeks with no treatment; Test Groups 1 and 2 completed 30 minute yoga sessions three to four times a week for eight weeks. The Sit and Reach Test was used to test the subjects' flexibility, and my own modified treadmill protocol was used to test their cardiorespiratory endurance. I found a statistically significant difference between the flexibilities of the control group and test groups. However, I found no statistical significance in the treadmill times between the control group and the test groups. There was no significant evidence to prove that an increase in flexibility will increase cardiorespiratory endurance.

Keywords: *Yoga, Cardiorespiratory Endurance*

INTRODUCTION

Athletes are always trying to find techniques that will give them an extra edge on their competition. In order to get your body to perform at its full potential, you have to understand how your body works at the musculoskeletal level. By having a better understanding of how your body works, you are able to focus on the things that are necessary for optimal performance.

The importance of flexibility on muscle and cardiorespiratory endurance is still unclear. There is little research that confirms that an increase in a person's flexibility will increase their muscle and cardiorespiratory endurance. However, two possible explanations have been proposed. The first explanation is that increased flexibility leads to less muscle resistance from contraction and tension, which leads to less energy expended during activity (Shrier, 2005). Stretching elongates the muscle decreasing the velocity of its contractile component, which has a negative effect on high-power short-term exercise but could possibly aid low-power long-term exercise (Nelson, et al., 2005).

The second explanation states that the key to preventing premature muscle fatigue is proper stretching methods, or by increasing your range of flexibility (Schwellnus, 1999). By increasing your range of flexibility, you are also increasing your economy of motion, or the amount of oxygen required to run a given distance. The build-up of lactic acid in skeletal muscles is caused by the lack of oxygen getting to the muscle, which occurs more in shortened, or tight, muscles (Shrier, 2005). Skeletal muscle cramps are a common problem encountered by endurance athletes. The two most important risk factors include muscle fatigue and poor stretching habits.

I would like to test whether increasing a person's flexibility will improve a person's muscle and cardiorespiratory endurance and reduce skeletal muscle cramps, which would improve the performance of endurance athletes.

MATERIALS AND METHODS

This experiment included three groups: (1) Control Group, (2) Test Group #1, and (3) Test Group #2. While conducting this experiment, I first had to test the flexibility of each of the subjects being used in the experiment. To test their flexibility, I used the Sit and Reach Test.

Table 1. Guide for expected scores (in cm) for adults using the Sit and Reach Test.

	Men	Women
Super	> +27	> +30
Excellent	+17 to +27	+21 to +30
Good	+6 to +16	+11 to +20
Average	0 to +5	+1 to +10
Fair	-8 to -1	-7 to 0
Poor	-19 to -9	-14 to -8
Very Poor	< -20	< -15

Each subject was asked to sit on the floor with their legs straight out in front of them and the back of their knees flat to the floor. With one hand placed on top of the other and their palms down, each subject reached forward along the meter stick as far as possible. Before recording their results, the subjects received three practice tests. On the fourth reach, the subject was asked to hold their reach for two seconds. To score the subjects' results I rounded to the nearest centimeter. If their reach goes beyond

their toes it's a positive recording; if their reach is before their toes it's a negative recording.

After testing each subject's flexibility, I tested their cardiorespiratory endurance using my own protocol. I modified my protocol from the Bruce Treadmill Protocol. My protocol is made up of seven stages. Each subject was timed to see how long they could withstand the test. In other words, they were asked to endure the test until they felt like they couldn't continue any longer. I also monitored and recorded their heart rate and oxygen saturation prior to and after the treadmill test as an objective measure of their physiological performance. I measured their heart rate and oxygen saturation using iWorx 214 by CB Sciences, Inc, pulse oximeter probe PO2-100D, and Labscribe as the computer software.

Table 2. My modified treadmill protocol (MTP) vs. the Bruce Treadmill Protocol (BTP). The treadmill protocol was used to test the cardiorespiratory endurance of each subject.

Stage	MPH		Grade		Duration
	MTP	*BTP*	*MTP*	*BTP*	
1	2.5	1.7	5%	10%	3 min.
2	3.3	2.5	7%	12%	3 min.
3	4.1	3.4	9%	14%	3 min.
4	4.9	4.2	11%	16%	3 min.
5	5.7	5.0	13%	18%	3 min.
6	6.5	5.5	15%	20%	3 min.
7	7.3	--	15%	--	3 min.

Subjects in the Control Group did not perform any yoga sessions in the eight week period. The subjects in Test Group #1 and Test Group #2 were asked to perform 30 minutes of yoga (with an emphasis on conditioning for athletes) three to four times a week for eight weeks. The eight week yoga experimental design is similar to that of Schroeder and O'Connor (2005) with the exceptions of the modified emphasis on yoga for conditioning athletes, using college-aged men and women, and using active subjects. At the end of week eight, I tested and recorded the results of the control group again. The subjects in Test Group #1 were retested *the day of* their last yoga session at the end of week eight. However, the subjects in Test Group #2 were retested *the day after* their last yoga session at the end of week eight.

RESULTS

As you can see in Table 3, the flexibility of all eight subjects in the test groups increased. Five of the subjects in the control group had an increase in flexibility and three had a decrease in flexibility. The average increase of flexibility in Test Group #1 was 14 cm. Test Group #2 subjects increased an average of 9 cm, while the Control Group had an average increase of 1 cm.

The times in Table 4 conclude that the Control Group *decreased* an average of eleven seconds between the first treadmill test and the second. I also concluded that Test Group #1 *increased* an average of ten seconds, and Test Group #2 *increased* an average of twenty-five seconds.

Table 3. The Sit and Reach results of each subject from the first and second trials.

Control Group	First (cm)	Second (cm)	Difference (cm)
Subject 1	-5	-10	-5
Subject 2	+13	+10	-3
Subject 3	-3	-5	+2
Subject 4	+8	+18	+10
Subject 5	+3	+8	+5
Subject 6	+20	+23	+3
Subject 7	+3	-10	-13
Subject 8	-10	+1	+11
Test Group #1			
Subject 9	-1	+8	+9
Subject 10	-3	-1	+2
Subject 11	-15	+10	+25
Subject 12	-20	0	+20
Test Group #2			
Subject 13	-20	-5	+15
Subject 14	+3	+13	+10
Subject 15	+23	+28	+5
Subject 16	+10	+17	+7

Table 4. The times for each subject from the first treadmill test and the second treadmill test.

Control Group	First (min)	Second (min)	Difference (s)
Subject 1	16:10	14:07	-123
Subject 2	13:21	14:03	42
Subject 3	13:01	13:00	-1
Subject 4	12:06	11:37	-29
Subject 5	14:00	12:00	-120
Subject 6	15:23	17:50	147
Subject 7	11:59	11:36	-23
Subject 8	15:10	15:30	20
Test Group #1			
Subject 9	16:03	16:17	14
Subject 10	12:35	12:32	-3
Subject 11	14:49	14:18	-31
Subject 12	13:00	14:00	60
Test Group #2			
Subject 13	19:30	20:01	31
Subject 14	17:04	17:30	26
Subject 15	12:12	11:53	-19
Subject 16	10:00	11:00	60

First I applied a t-Test among the Test Groups and found that there was no statistically significant difference between their flexibility variations. The p-value was 0.815 and the power of the performed test when alpha equaled 0.050 was 0.050. However, the power of the performed test was below the desired power of 0.800; therefore, I would be less likely to detect a difference when one actually exists. For additional statistics see Table 5.

Next, I applied t-tests between the flexibilities of

the Control Group and the combined Test Groups. The p-value was 0.020 and the power of the performed test when alpha equaled 0.050 was 0.619. For additional statistics see Table 5. The difference in the mean values of the two groups is greater than would be expected by chance; therefore, there is a statistically significant difference between the two groups.

After depicting the significance in flexibility, I applied the same steps to the subjects' times. I found that there was not a statistically significant difference in times between Test Group #1 and Test Group #2. The p-value of this t-Test was 0.585 and the power of the performed test when alpha equaled 0.050 was 0.050. Again, the power of this performed test was considerably lower than the desired power of 0.800. For additional statistics see Table 5.

When applying a t-Test to the times of the Control Group and combined Test Groups, I found that the p-value was 0.411 and the power of the performed test when alpha equaled 0.050 was 0.050. This would signify that the difference in the mean values between these two groups is not great enough to reject the possibility that the difference is due to random sampling variation. For additional statistics see Table 5. Tests were run using the computer software program SigmaStat 3.5.

Table 5. (a) Statistics from the t-Test between the flexibility differences of Test Group #1 and Test Group #2. (b) Statistics from the t-Test between the flexibility differences of the Test Groups and the Control Group. (c) Statistics from the t-Test between the time differences of Test Group #1 and Test Group #2. (d) Statistics from the t-Test between the time differences of the Test Groups and the Control Group.

(a)

Name	N	Mean	Std Dev	SEM
TG #1	4	14.065	10.868	5.434
TG #2	4	9.207	4.564	2.282

(b)

Name	N	Mean	Std Dev	SEM
TGs	8	11.636	8.142	2.878
CG	8	0.804	8.111	2.868

(c)

Name	N	Mean	Std Dev	SEM
TG #1	4	10.000	38.149	19.074
TG #2	4	24.500	32.645	16.322

(d)

Name	N	Mean	Std Dev	SEM
TGs	8	17.250	33.771	11.940
CG	8	-10.875	87.609	30.974

DISCUSSION

There was significant evidence supporting that the eight weeks of yoga did increase the Test Groups flexibility notably. However, there was no significant evidence to prove that an increase in flexibility will increase cardiorespiratory endurance. My results could have been due to random sampling variation. The adequate sampling size for this experiment should have been 33 subjects.

My results were very similar to those of Schroeder and O'Connor's (2005). They concluded that an eight week yoga program for college-aged women may promote improvements in muscular endurance and hamstring flexibility but not cardiorespiratory endurance.

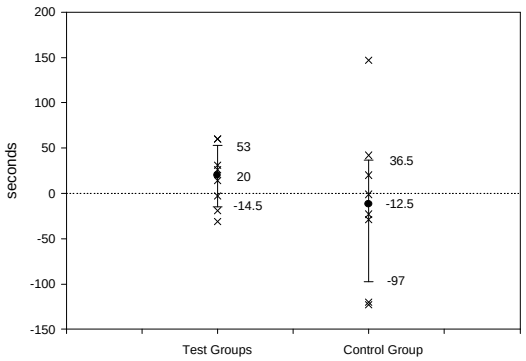

Figure 1. Displays a comparison of the differences in the times of the Test Groups and the Control Group.

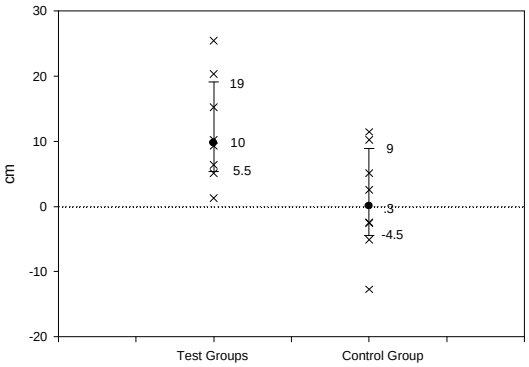

Figure 2. Displays a comparison of the differences in the flexibilities of the Test Groups and the Control Group.

ACKNOWLEDGEMENTS

I would like to thank Dr. Jonathan Frye, Associate Professor of Natural Science, for his time and advice; the McPherson College Science Department for funding and lending their pulse oximeter; and McPherson College for the use of their fitness room facilities.

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