Research

A Study of the Impact of Yoga *Âsana* on Perceived Stress, Heart Rate, and Breathing Rate

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Abstract

The purpose of this study was to examine how practicing Yoga âsana *influences perceived stress level and physiological indicators of stress, such as resting heart rate and breathing rate. The sample consisted of 79 moderately-stressed students enrolled in Yoga* âsana *classes at a university in Southern California. Students participated in Yoga* âsana *classes for ten weeks as part of the General Education (GE) Physical Education curriculum. Participants reported data pre- and post-class on resting heart rate, unregulated breathing rate, and perceived stress level. We hypothesized that the practice of Yoga* âsana *would be associated with decreased stress. Results: Yoga* âsana *was associated with positive pre- to post-class changes on perceived stress, heart rate, and breathing rate. Participants' pre-class perceived stress and breathing rate decreased during the ten-week period. However, participants' pre-class resting heart rate did not change significantly over the course of the study.*

Introduction

The purpose of the study was to conduct a preliminary exploration of how *Vinyasa Krama âsana* in the style of T. Krishnamacharya and TKV Desikachar influence stress-related responses of the mind, body, and breath. "Stress" can be defined as the mental, emotional, and physiological responses to the demands of life.[1] Increased sympathetic activation and the release of stress hormones, including adrenaline, lead to increases in heart rate, blood pressure, breathing, body temperature, and muscle tension. In contrast, the relaxation response has been proposed as an antidote to stress; relaxation decreases heart rate, breathing, body temperature, and muscle tension.[2-3]

For many students, college is a time of chronic stress, and students with greater perceived stress are more susceptible to headaches, sleep disturbances, and illnesses, such as the common cold.[4-7] It is important for college students to establish a method for coping with chronic stress, and many students are enrolling in Yoga classes to reduce stress and experience relaxation.

Previous research shows that Yoga can decrease perceived stress and physiological indicators of stress. For example, Gupta, Khera, Vempati, Sharma, and Bijlani[8] found that a comprehensive ten-day Yoga lifestyle intervention consisting of *âsana*, *prânâyâma*, meditation, philosophy, and nutrition significantly decreased anxiety in a group of medical patients. Telles, Narendran, Raghuraj, Nagarathna, and Nagendra[9] found that after practicing Yoga *âsana* for one hour daily for six months, students showed a significant decrease in resting heart rate and breathing rate. Importantly, prior to the intervention, the students in this study showed an elevated heart rate and breathing rate consistent with chronic stress.

Both of these studies examined the effects of intensive Yoga immersions, which may not be feasible for many people, especially college students. One study that looked at a more feasible intervention—ten weeks of a once-a-week hour-long Yoga class—found that Yoga significantly decreased self-reported stress and anxiety in a group of adults with mild-to-moderate levels of stress. This study suggests that a shorter intervention may be effective; however, the researchers did not measure physiological changes in stress.

The present study examines both the short-term (i.e., pre/post the one-hour Yoga class) and long-term (i.e., pre/

post the ten-week program) effects of a one-hour Yoga *âsana* practice on perceived stress, heart rate, and breathing rate in a group of moderately-stressed college students. Seventy-nine students participated in twice-weekly Yoga *âsana* classes for ten weeks as part of a General Education requirement.

Based on previous findings, we expected that a one-hour Yoga class would have both short-term and long-term effects on perceived stress, heart rate, and breathing rate. The hypotheses for the study were as follows:

1. Students' perceived level of stress will decrease between the beginning and the end of each Yoga *âsana* class.
2. Students' perceived level of stress will decrease over the course of the ten-week program, as a cumulative response to developing skills to cope with stress.
3. Students' resting heart rate will decrease between the beginning and the end of each Yoga *âsana* class.
4. Students' resting heart rate will decrease over the course of the ten-week program, as a cumulative response to developing skills to cope with stress.
5. Students' breathing rate will decrease between the beginning and the end of each Yoga *âsana* class.
6. Students' breathing rate will decrease over the course of the ten-week program, as a cumulative response to developing skills to cope with stress.

Methods

Participants

The sample consisted of 79 students at a university in Southern California. Seventy-three females and six males participated, ranging from 18-54 years (M = 23±9.9 years). Students participated in Yoga *âsana* classes for ten weeks as part of the General Education (GE) Physical Education curriculum.

Procedures

The classes met twice a week for 60 minutes each session. The style of Yoga *âsana* was *Vinyasa Krama* in the tradition of T. Krishnamacharya and TKV Desikachar. The students participated in standing poses, forward bends, backward bends, lateral bends, and twists over the course of the ten weeks. The practice changed each week, depending on the needs of the participants. This said, the general *âsana* sequence was standing poses first, then supine poses, mild inversions, prone backbends, and seated postures last. It should be noted that the *âsana* is secondary to the breath in this type of Yoga practice. See Appendix A for details about this approach.

Measures

The participants were instructed to complete a personal chart at the beginning and the end of each Yoga class. Specifically, this entailed coming to class, resting for five minutes lying on their backs, and then providing pre-class ratings. This ensured that any post-practice decrease in heart rate or breathing rate could not be attributed merely to the practice of resting in relaxation pose. At the end of each class, the students repeated measurements.

Before and after each class, participants were asked to record their stress level in the present moment on a scale of 1 to 10 (l = low, 5 = moderate, and 10 = high). Next, they were asked to count the number of seconds in their breathing pattern by watching the clock and following the breath on inhalation and exhalation (longer inhalations and exhalations reflecting a lower breathing rate). Last, they were asked to take their own heart rate while watching the clock for 60 seconds. The heart rate was taken on both the right and left wrist in the Yoga *âsana* tradition of T. Krishnamacharya (see Appendix B for details.) Although it is controversial to have students take a manual heart rate instead of using a heart-rate monitor or an electrocardiogram, this method is in alignment with ancient methods of Yoga *âsana* theory and practice. The ability to observe one's own state of body and mind is one of the aims of Yoga practice, and this method was considered part of the practice itself. If the student had trouble taking the pulse, a teacher/helper was nearby to assist in getting an accurate reading.

Analysis

The first three weeks of the study were considered training weeks. The training was to ensure that proper resting heart rate and resting breathing rate were being recorded, and that the use of traditional pulse-reading was not producing inaccurate data. Many students were having trouble taking accurate heart rates the first few weeks, but gained sensitivity by the fourth week. The accuracy of the data was checked by teachers/helpers who spot-checked the pulse of several students each class to make sure their readings were accurate. If there was a discrepancy between the reading of the student and the research helper, further training was given to the student. Although students completed self-observations in every class, data was collected for analysis only from weeks 4, 6, 8, and 10. The decision to use data from weeks 4, 6, 8, and 10 was consistent with the goal of the study, which was to see if there were significant changes over time in perceived stress, heart rate, and breathing rate. Data were analyzed with the SPSS 14.0

statistical package. All hypotheses were analyzed using descriptive statistics for weeks 4, 6, 8, and 10, and 2-tailed paired sample *t*-tests with a 95% confidence interval comparing weeks 4 and 10.

Results

Participation

The drop-out rate for the study was extremely low due to the fact that the subjects were enrolled in a college-level course. Eighty-four students began the study and 79 completed the study.

Perceived Stress

Hypothesis 1 was confirmed. As shown in Table 1, perceived stress level significantly decreased from the beginning to the end of a single class session at week 4, week 6, week 8, and week 10. The average change is not only statistically significant, but was also experientially significant, reflecting a change from moderate to low levels of perceived stress.

Hypothesis 2 was partially confirmed. Table 2 shows that the perceived stress levels of students did not significantly decrease over the course of the study if only week 4 and week 10 are compared. However, there was a statistically-significant decrease in students' pre-practice perceived stress levels from week 4 to week 8. Given that the end of the quarter is a particularly stressful period of final exams, the elevation in stress at week 10 is perhaps not unexpected.

Heart Rate

Hypothesis 3 was confirmed. As shown in Table 3, heart rate, as measured on both the right and left wrists, significantly decreased from the beginning to the end of a single class session at week 4, week 6, week 8, and week 10.

Hypothesis 4 was not supported by the data. There was no significant change in pre-practice resting heart rate from week 4 and to week 10. See Table 4.

Breathing Rate

Hypothesis 5 was confirmed. As shown in Table 5, the length of inhalation and exhalation significantly increased from the beginning to the end of a single class session at week 4, week 6, week 8, and week 10.

Hypothesis 6 also showed the anticipated results. As shown in Table 6, the length of inhalation and exhalation measured before Yoga practice significantly increased from week 4 to week 10.

Discussion

Summary

This study showed that for college students who experience moderate stress, Yoga *âsana* is associated with positive short-term and long-term changes in stress-related responses of the mind, body, and breath.

The short-term effects for perceived stress level, heart rate, and breathing rate suggest that Yoga has a positive

Week	T-test	Pre-mean	Post-mean
4	$t(69) = 10.4, p < .001$	5.0	2.7
6	$t(64) = 9.9, p < .001$	5.0	3.0
8	$t(67) = 10.7, p < .001$	4.1	2.4
10	$t(66) = 7.8, p < .001$	4.6	2.9

Table 1. ***Mean perceived stress level before and after Yoga class (1 = low, 5 = moderate, 10 = high).***

Week	T-test	Pre-mean	Post-mean
4-10	$t(58) = 1.7, p < .087$	5.0	4.6

Table 2. ***Change in pre-class perceived stress level from week 4 to week 10.***

Week	Wrist	T-test	Pre-mean	Post-mean
4				
	Right	t(69) = 3.2, p < .002	73	69
	Left	t(68) = 5.1, p < .001	75	66
6				
	Right	t(63) = 5.1, p < .001	75	66
	Left	t(64) = 5.8, p < .001	75	69
8				
	Right	t(67) = 4.3, p < .001	74	69
	Left	t(66) = 3.5, p < .001	73	69
10				
	Right	t(65) = 5.0, p < .001	74	69
	Left	t(64) = 4.5, p < .001	75	69

Table 3. ***Mean resting heart rate before and after Yoga class (beats per minute).***

Week	Wrist	T-test	Pre-mean	Post-mean
4-10	Right	t(58) = 1.0, p < .308	75	74
4-10	Left	t(58) = -.54, p < .592	73	74

Table 4. ***Change in pre-class resting heart rate from week 4 to week 10.***

effect and helps to create the relaxation response in the body. Importantly, the starting point of this comparison (pre-class) followed an initial five-minute relaxation period, suggesting that the Yoga practice had an effect above and beyond the practice of simply resting in relaxation position.

The long-term improvements in the relaxation response also showed promising results in two of the three variables. There was a progressively significant decrease in stress levels in weeks 4, 6, and 8. However, in week 10 the perceived stress level increased to be similar to the levels at which the students had begun the quarter. It would make sense that the students became more stressed during the period of final exams, even though they were taking a Yoga class, and it is possible (although we did not test this hypothesis) that the students' stress levels during exams were lower than they would have been without Yoga practice. There was significant improvement in uncontrolled breathing rate from week 4 to week 10. Both the length of the inhalation and the exhalation increased. The ability to breathe long, smooth breaths on both inhalation and exhalation is a sign of a healthy state of relative relaxation.

Week	Breath Phase	T-test	Pre-mean	Post-mean
4				
	Inhale	t(69) = -7.1, p < .001	4.5	6
	Exhale	t(69) = -6.5, p < .001	4.9	6.3
6				
	Inhale	t(64) = -6.2, p < .001	4.6	6
	Exhale	t(64) = -7.6, p < .001	4.8	6.3
8				
	Inhale	t(67) = -7.4, p < .001	4.9	6.1
	Exhale	t(67) = -6.0, p < .001	5.4	6.5
10				
	Inhale	t(65) = -5.8, p < .001	5.3	6.7
	Exhale	t(66) = -6.1, p < .001	5.6	6.8

Table 5. ***Mean breathing length before and after Yoga class (in seconds).***

Week	Breath Phase	T-test	Pre-mean	Post-mean
4-10	Inhale	t(57) = -2.9, p < .006	4.5	5.3
4-10	Exhale	t(58) = -3.1, p < .002	4.9	5.6

Table 6. ***Change in pre-class breathing length from week 4 to week 10***

The average heart rate did not change over the quarter. One possible reason for this is that the sample of college students began and finished the quarter with healthy heart rates. This is in contrast to the Telles et al.[9] study, in which the students came into the study with elevated heart rates and breathing rates consistent with chronic stress patterns. The short-term effects of lowered heart rate may reflect the strength of the Yoga-induced relaxation response, rather than a "training" adaptation (such as is seen in cardiovascular exercise) that would influence baseline resting heart rate.

Limitations

An important limitation of the study is that there was no control group. It would have been useful to see the heart rates, breathing rates, and perceived stress levels of students in a jogging class or even a Yoga philosophy lecture class. This would help to determine the unique benefits of Yoga *âsana* practice. It would also give more information about how the perceived stress levels of college students typically fluctuate during the academic quarter.

A second limitation of the study was that the students used self-reported measurement of heart rate and breathing

rate. The technique of having students manually measure their breath and heart rate is an excellent way for students to connect to their bodies. Additionally, it is a tool that can be used in their future Yoga practice to determine the effects of certain practices on their bodies. However, we could be more confident in the accuracy of measurements if a heart rate monitor and a breathing monitor were used during data collection.

Finally, it is possible that the students in the study had an unconscious or even an intentional reporting bias with respect to one or all three variables. For example, they may have wanted to please the teacher and demonstrate that they experienced a relaxation response. However, the primary researcher and research assistants went to great lengths to make sure the students recorded the data accurately. Also, the fact that heart rate did not show the predicted decrease over the course of the study suggests that there was no uniform reporting bias in the direction of confirming the researchers' hypotheses.

Future Research

Future research should include further analysis of heart rate and breathing rate with the use of heart rate and breathing monitors. This would provide a more accurate assessment of the changes that happen as a result of Yoga practice. In a follow-up study, it would also be important to have a control group, so that changes in stress level can be effectively studied as students progress through an academic quarter and ultimately to final exams. Additionally, it would be interesting to compare the results to other styles of Yoga *âsana* to see if the positive changes in stress responses are a common benefit of other Yoga *âsana* styles. Because there is such a wide variety of Yoga styles in the market, we need to be very specific in the research about which styles are creating positive and desired results. It would also be interesting in future research to compare and contrast the frequency, duration, and intensity of Yoga *âsana* practice, similar to research that has been done with cardiovascular exercise. Such research would determine whether there is a maximally effective or minimally required "dose" of practice for stress reduction.

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Appendix A

The principles that governed the practice for the ten-week quarter were as follows:

1. The focus of the practice is the breath and the *âsana* as a tool used to maximize breathing potential.
2. Warm-up the body with gentle and simple postures at the beginning of the practice and lead into more challenging postures.
3. Practice moving in and out of an *âsana* dynamically synchronized with proper breathing patterns before holding it statically.
4. Each day a goal posture was chosen as the peak of the practice.
5. Practice a simple and gentle counter pose immediately following difficult *âsanas*.
6. Cool-down properly by gentle postures to prepare for further *prânâyâma* and meditation.

Yoga *âsana* as defined by T. Krishnamacharya and TKV Desikachar assumes that each breath and each movement is consciously controlled. Changes in breath and movement would be considered voluntary during the actual Yoga practice. Each movement of the body is coordinated with either an inhalation or an exhalation depending upon the movement of the spine. Another key component of this type of Yoga is that the length of the movement (the number of seconds it takes to make the movement) and the length of the inhalation or exhalation are synchronized with one another; the movement and the breath begin and end at the same time. This requires quite a bit of concentration and means that the attention/mind of the practitioner is fully engaged in the practices of the Yoga *âsana* the entire time.[10]

Appendix B

It should be noted that the measurement of heart rate in the West is often done utilizing a heart rate monitor or an electrocardiogram. The tool chosen to measure heart rate in this study was the human hand. At the end of the study, the Yoga students were taught the basics of *Nadi Pariksa* theory as part of their Yoga class experience and curriculum. *Nadi Pariksa* is an ancient healing modality from the Ayurvedic and Yoga traditions. The theory suggests that there are over 72,000 energy channels in the body, and that as we age, become ill, or are injured, these channels can become blocked. The blocking of the channels is reflected in the pulse felt at the wrists, ankles, pelvic crease, and many other places in the body. Both Ayurvedic medicine and Chinese medicine theory suggest that many disease patterns can be diagnosed just by feeling the pulse of the patient. In an attempt to keep the Yoga experience holistic in nature, it would seem inappropriate to use tools such as a heart rate monitor. Instead, a decision was made before the study began that reading the pulse by hand would provide a more authentic Yoga experience for participants. The researchers felt it was important for students to feel for themselves the power of the physiological changes that happened in their bodies as the classes and the quarter progressed.