Impact of *Viparita Karani* yoga inversion posture on mean arterial pressure in young women

Donaldson, Nicole; Martini, Bethany; Sharp, Stephanie; Tierney, Jessie
2 June 2015
Tuesday 1PM Biology 349 Lab
Western Washington University
Adrianne Akmajian, TA; Janice Lapsansky, PhD

ABSTRACT

In this study, we researched the impact of *Viparita Karani* on mean arterial pressure in young women. *Viparita Karani* is an inversion posture which is thought to lower blood pressure. We expected to find that mean arterial pressure decreases from baseline readings in participants who practice the pose for five minutes. We controlled for time of day, duration in pose and *Pranayama* (breathing exercise), environment, gender, age, and health. Subjects were randomized into the control or treatment group. Control groups sat against the wall while treatment groups assumed the posture of *Viparita Karani* (legs up the wall). Blood pressure was taken at three stages: a baseline, after a five minute breathing exercise, and five minutes after the breathing exercise ended. We found that there was no significant difference in mean arterial pressure (MAP) between control and treatment groups in any of the three stages in which we took blood pressure readings. *Pranayama* was found to significantly decrease MAP in both control and treatment groups. Future expansions of this study should incorporate a larger sample size, include both genders, include a third treatment group (*Viparita Karani* without *Pranayama*), investigate changes in ankle-brachial index, include an anxiety level survey before and after the treatment, institute a full inversion, and test the treatment over a longer period of time.

INTRODUCTION

Today, yoga is practiced as a complement to modern medicine by 20.4 million Americans (Barnes, et al, 2004; Yoga Journal, 2012; McCall, 2007). Ninety-three percent of the 755 Integrative Hospitals in the US provide yoga to their patients to enhance their physical and spiritual well-being (Isaacs, 2007). This ancient system of holistic healing encompasses an integrative practice linking physical postures, breathing, sensory awareness, meditation, and ethical conduct (Iyengar, 1993; Feuerstein, 2001). This link between body, mind, and breath comes from its Sanskrit definition, *to yoke* or *to unite* (Feuerstein, 2001). A growing body of researchers are now seeking to quantify the physiological effects of yoga (Jerath, et al, 2006). Recent research documents a wide range of benefits from improving pregnancy outcomes to treating PTSD to managing low back pain, all of which supports the practice of yoga as a low-cost and effective modality in the treatment and prevention of disease (Narendran, et al, 2005; Cabral, et al, 2011; Tilbrook, et al, 2011).

Inverted postures, where the head is at or lower than the level of the heart, are of particular interest in this study where we explore the cardiovascular, respiratory, and psychological effects of *Viparita Karani* (legs up the wall pose). Inversions are touted by teachers and practitioners as a way to control and lower blood pressure, thereby reducing anxiety (McCall, 2007; Long, 2008; Iyengar, 1994). The clinical application of these postures could greatly improve the lives of Americans who suffer from anxiety and depression, and the 80 million US adults diagnosed with primary hypertension (Raub, 2002; Bhavani, et al, 2014; CDC, 2012; AHA, 2015).

In a university setting where students are subjected to high academic stress, poor nutrition, and poor social and sleeping habits, yoga offers an affordable anytime, anywhere tool for coping with stress and anxiety (Eisenberg, et al, 2007; Panesar and Valachova, 2011). If left untreated, chronic long term exposure to stress invokes multiple blood pressure spikes, causing blood vessel damage over time. As a result, diseases such as hypertension and heart disease are on the rise (McEwen and Stellar, 1993; Cohen, et al, 2011; Murugesan, et al, 2000).

Physiology has elucidated the intrinsic basis for yoga's influence on blood pressure. Inverted postures in individuals with normative blood pressure activate baroreceptors at the carotid sinus and aortic arch. As aortic and carotid pressure increases, the baroreceptor reflex increases parasympathetic nervous system activation, resulting in vasodilation, a lowered heart rate, lowered cardiac output, and therefore lowered blood pressure (Sherwood, 2003; Long, 2008).

Viparita Karani (legs up the wall pose) is a yoga *asana* (posture) in which the practitioner lays on the floor with their hips elevated slightly and their legs up a wall (Figure 1). The pose has few contraindications and is less demanding than classical inversions such as

headstand, shoulder stand, or downward facing dog, making it suitable for beginners or people with heart disease (Kaminoff and Matthews, 2012; Iyengar, 1994). Yoga instructors teach this as a posture that can have both deeply relaxing and rejuvenating effects, depending upon how it is practiced. If a practitioner complains of the inability to fall asleep, they are advised to practice *Viparita Karani* for at least five minutes, then roll directly into bed, keeping the head at the level of or lower than the heart. This pose is also recommended as a midday pick-me-up, as sitting up after the posture can have a restorative and mildly stimulating effect (Coulter, 2001; Lasater, 2011). The purpose of this study is to support anecdotal advice with quantitative results.

Figure 1. Diagram of the classical *Viparita Karani* yoga inversion posture (Corcoran, 2014).

This study investigates if the *Viparita Karani* yoga inversion posture along with *Pranayama* (conscious breathing) can lower blood pressure in college age women, and if practicing the inversion lowers blood pressure more than *Pranayama* alone. First, we expect that the *Pranayama* practice for both treatment and control groups lowers MAP (mean arterial pressure) from the baseline measurement. We also expect to find that practicing *Viparita Karani* significantly lowers MAP; we suspect this effect will persist after the practitioner returns to an

upright seated position. We anticipate that overall MAP will lower more in our *Viparita Karani* group than in the control group practicing *Pranayama* in a seated position. The implications of these findings could prove to be a useful coping strategy for college students experiencing hypertension symptoms as a result of daily stress and anxiety.

MATERIALS & METHODS

Female subjects (n=30) ages 18-23 with no previous history of heart disease, glaucoma, aneurysm, or hypertension were randomized into a control and treatment group. Gender was controlled to eliminate variability between sexes. Cardiovascular history was taken to ensure safety and to eliminate extraneous effects on blood pressure. Every third subject was placed into the control group. Subjects were asked to answer questions based on prior yoga experience, check a box if they felt healthy, report medical history, and sign an informed consent form. The study was conducted in a soundproof room, between the hours of 1:00 and 4:30pm.

Stage 1: Baseline blood pressure was measured using automatic sphygmomanometers after all subjects were seated for two minutes in an upright position against a wall with their legs outstretched (L position). After a demonstration, the treatment subjects (n=20) entered the *Viparita Karani* posture while the control subjects (n=10) maintained their L position. We played a five minute audio recording that led all subjects through a *Pranayama* practice. To raise the heart above the head, the treatment group used a three-inch folded blanket as a bolster supporting their hips. The control group sat on the same size blankets.

Stage 2: Blood pressure of all subjects was measured directly after the recording ended. The treatment group was in the *Viparita Karani* posture and control group maintained the L

position. Following the measurement, subjects in the treatment group were asked to sit in the L position, in the same manner as the control group.

Stage 3: Five minutes after the breathing exercise ended, a final blood pressure was measured in both groups.

All three blood pressure measurements were reviewed. Pulse pressure was calculated by subtracting diastolic from systolic pressure and MAP was calculated by adding diastolic pressure plus ⅓ of the pulse pressure for each individual at each time interval. Dependent t-tests in Excel were used to compare percent change between stages within the same groups. Independent t-tests were used to compare the differences in MAP between the treatment and control groups in each of the defined stages. Standard error was calculated for all data.

RESULTS

General trends for the average mean arterial pressure (MAP) for the treatment and control group showed a decrease after the five minute *Pranayama* exercise (Stage 2). The MAP of the treatment group increased at Stage 3 after a five minute recovery, whereas the MAP of the control group did not change. The average MAP for the treatment group was higher than the control group throughout the study, though that difference was not significant (Figure 2).

The largest average percent change for both groups occurred from Stage 1 to Stage 2, after the initial blood pressure measurement was taken and when the *Pranayama* recording ended (Figure 3). From Stage 2 to Stage 3, the treatment group's MAP increased by 4.4%; the control group did not increase. Despite these visual differences, there were no significant differences between the control and treatment group measures.

There were significant differences within each group at the 95% confidence level. The *Pranayama* group decreased 5.6% from the baseline MAP ($p = 0.023$) and the *Viparita Karani* group decreased by 6.0% ($p = 0.0016$). The *Viparita Karani* group's MAP increased by 4.4% after the posture was completed and they returned to the L position ($p = 0.035$). Between Stage 1 and Stage 3, the control group's MAP decreased by 5.6% overall ($p = 0.024$; Figure 3).

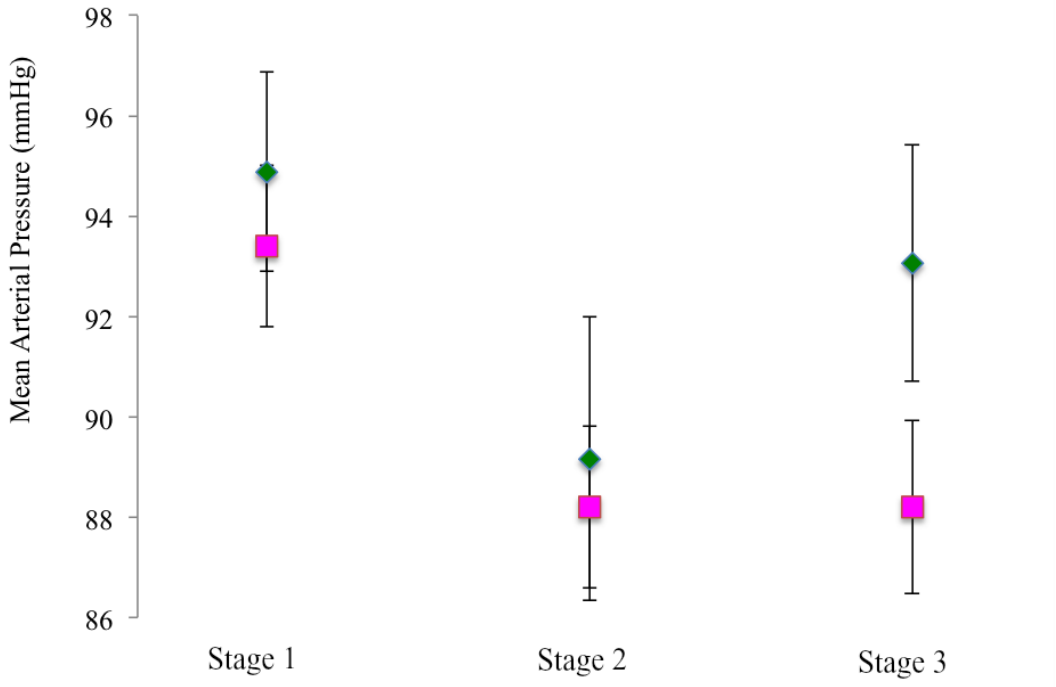

Figure 2. Average MAP for the treatment (green) and control (pink) groups at three study stages. Stage 1 shows the baseline measure. Stage 2 was measured after a five-minute *Pranayama* recording. Stage 3 was measured after five minutes of recovery from the practice. Error bars show standard error.

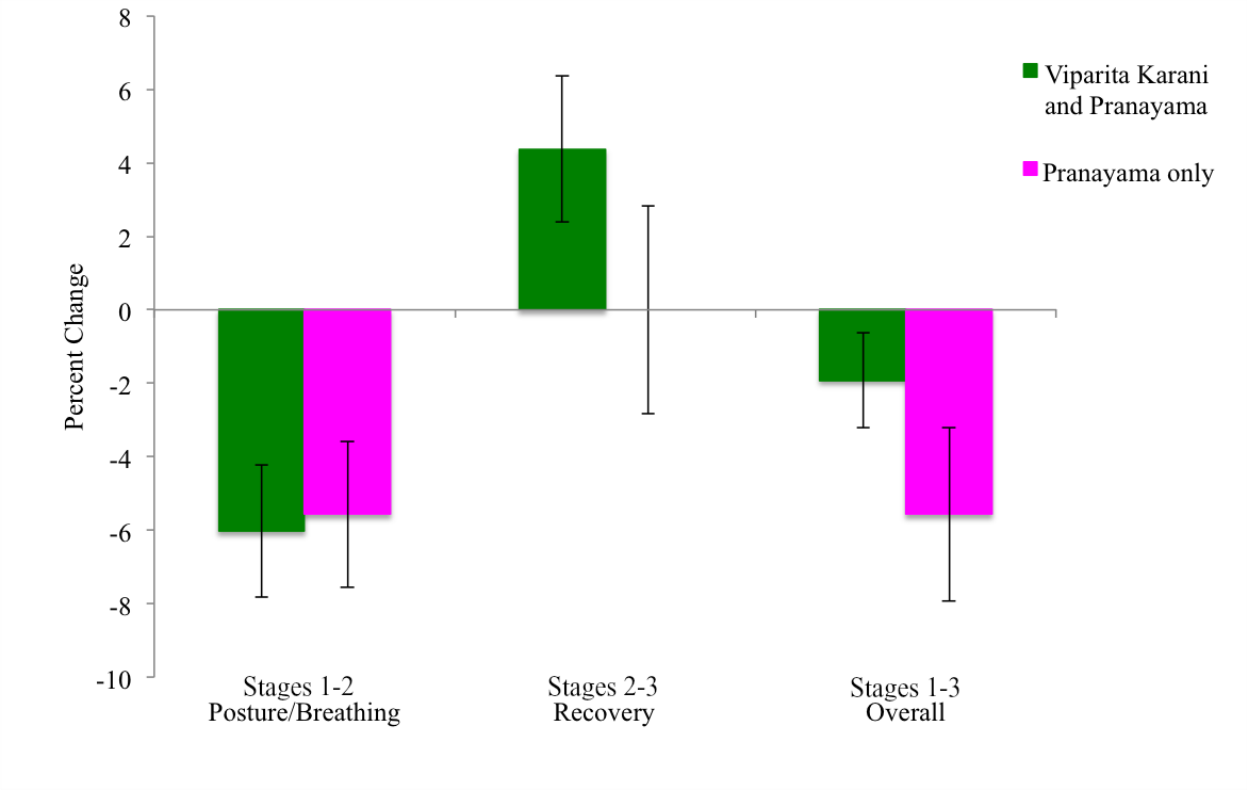

Figure 3. Average percent change in mean arterial pressure (MAP) for the treatment and control groups during three time intervals: Posture/Breathing shows the difference between Stages 1 and 2, Recovery is between Stages 2 and 3, and Overall shows the difference between Stages 1 and 3. Error bars show standard error.

DISCUSSION

Our study explored the effect of *Pranayama* or *Viparita Karani* on mean arterial pressure (MAP). We observed differences between *Pranayama* practice and the *Viparita Karani* yoga inversion posture on MAP between study groups over the three stages, albeit results were not statistically significant at the 95% confidence level. We did, however, observe a significant difference in MAP within control and treatment groups, respectively (Figure 3). Contrary to our initial hypothesis, significant changes in MAP are more strongly related to the breathing practice than the physical posture. This conclusion needs further investigation, namely incorporating a second treatment group which practices *Viparita Karani* without *Pranayama* to disentangle the

effects of the breathing from the posture itself; although, in a typical yoga practice, both are simultaneously practiced.

Measured changes in blood pressure can be explained by the body's physiological response to differing pressures while the subjects transitioned into and out of the postures. Baroreceptors in the aortic arch and the carotid sinuses maintain homeostasis in the systemic circuit by detecting blood pressure changes (Sherwood, 2003). When inverting the body as in *Viparita Karani*, blood pressure increases suddenly, as blood rushes from the lower extremities into the upper thorax and head. This increase in carotid and aortic pressures activates the parasympathetic nervous system through the glossopharyngeal and vagus cranial nerves, which carry the information to the cardiovascular control center in the medulla. The parasympathetic response causes blood pressure to lower by decreasing cardiac output. When coming out of the pose, pressure detected by baroreceptors decreases and the sympathetic nervous system dominates, resulting in a return to near baseline levels of cardiac output and blood pressure. The body's homeostatic mechanisms are effective in keeping MAP within normal limits which could thereby result in little or no measurable difference resulting from the physical posture. This is one possible explanation for our absence of significant results.

These physiological mechanisms are consistent with classical instruction on the posture. By practicing *Viparita Karani* before bed and not elevating the head above the level of the heart, a practitioner has effectively stimulated the parasympathetic nervous system, and so long as they stay in the supine position while they roll into bed, they have created a condition which we would expect to promote sleep (Trinder, et al, 2001; Lasater, 2001). If *Viparita Karani* is to be used as a re-energizing posture, then sitting upright after the pose would stimulate the sympathetic nervous system. When the sympathetic nervous system dominates, blood pressure

increases as the body prepares to respond to fight or flight situations, and the practitioner gains a subjective feeling of being more alert and awake (Sherwood, 2003).

Additionally, in an inversion, the typical function of the veins and arteries is turned upside-down. One-way veinous valves, with help from the skeletal muscle and respiratory pump, aid in the transport of deoxygenated blood back to the heart against gravity. Arteries work by dilating and contracting smooth muscle to regulate blood flow from the heart to the extremities. In the *Viparita Karani* inversion, veinous blood from the legs— aided by gravity— drains readily toward the heart, whereas arterial muscles may have to work against gravity and dilate to get blood to reach the lower extremities. Blood pressure in the ankles during an inversion can read 40/0, and associated MAP drops as low as 13.3 mmHg. However, blood pressure at the level of the heart remains relatively stable due to baroreceptor proximity and the related role in maintaining homeostasis; namely, a MAP of 93.3 mmHg (Coulter, 2001).

Pranayama in both the treatment and control groups decreased MAP significantly (Figure 2). This conclusion is well-supported by studies exploring *Pranayama* and mind-body connection practices (Deckro, et al, 2002; Murugesan, et al, 2000; Raub 2002; Jerath, et al, 2006). Murugesan, et al (2000) showed that practicing Hatha Yoga (consisting of yoga and breathing) twice a day for eleven weeks is equally as effective as standard medical treatment in controlling hypertension. Reflexive breathing—regulated by autonomic pacemaker activity in the ventral respiratory group of the medulla—is superseded by conscious perception and control at the cortex during *Pranayama*. *Pranayama* has been shown to enhance parasympathetic activation which decreases oxygen consumption, heart rate, and blood pressure (Jerath, et al, 2006; Deckro, et al, 2002). Our data supports that *Pranayama* can help lower blood pressure in college age women.

Our study was limited by preconceived notions about the practice of yoga, our methodology, and small sample size. Our sample population was not truly random because participants were self-selected, and may have been affected by people's interest in yoga. The lack of difference between our experimental and control groups may be attributed to a number of variables. Subjects performed a mild inversion as opposed to a full inversion—such as shoulder stand or headstand—and effects may have been greater in these full inversions. Other factors that affect blood pressure were not controlled for in this study, including emotional or physiological stress which can increase sympathetic activity and raise blood pressure (Sherwood, 2003). For example, some students had exams directly after the study, some ran or biked to the study, and others consumed caffeine prior to the study. We had a relatively small sample of twenty treatment subjects and ten control subjects.

Future research should include a larger sample population to eliminate variance related to atypical physiological or psychological factors. We would like to incorporate an additional *Viparita Karani* group that does not practice *Pranayama* to help clarify if the posture has an effect on MAP. We would also incorporate a treatment sub-group that lays down during the 5-minute recovery to better quantify if this posture keeps the body in parasympathetic activation if the head is not raised above the heart. We would also find it meaningful to issue a survey to participants before and after the study to obtain a subjective reading of perceived stress levels and investigate this relation to blood pressure more directly. Many of our study subjects volunteered a subjective report at the end of the study such as "I feel so much better," or "That was so relaxing," and it would be useful to quantify these accounts on a 0-10 scale. It may be beneficial to include a study with both males and females to explore or rule out gender differences. A model investigating the effects of yoga tracked over time may prove useful for

expanding the effects of yoga inversion on blood pressure (Fishman, et al, 2014; Santaella, et al, 2011; Cohen, et al, 2011). Incorporating ankle-brachial index in our measures would bolster the strength of conclusions and enhance an understanding of the physiological impacts of inversion postures (Coulter, 2011).

CONCLUSIONS

Our study found that both *Viparita Karani* and *Pranayama* lowered MAP in college age women. Notably, *Pranayama* appeared to have a greater effect on lowering MAP and resisted the MAP rebound observed in the *Viparita Karani* group. By expanding our population size and demographics, including a third treatment group, measuring ABI, and including a self-reported anxiety level survey, future studies will elucidate the physiological effects of *Viparita Karani* on MAP.

LITERATURE CITED

American Heart Association. 2015. *About High Blood Pressure*. Online. Available: heart.org 24 April 2015.

Barnes, P., Powell-Griner, E., McFann, K., and Nahin, R. 2004. *Complementary and alternative medicine use among adults: United States, 2002*. Seminars in Integrative Medicine. 2(2): 54-71.

Bhavani, A., Ramanathan, M., Balaii, R., and Pushpa, D. 2014. *Comparative immediate effect of different yoga asanas on heart rate and blood pressure in healthy young volunteers.* International Journal of Yoga. Jul; 7(2): 89-95.

Cabral, P., Meyer, H., Ames, D. 2011. *Effectiveness of Yoga Therapy as a Complementary Treatment for Major Psychiatric Disorders: A Meta-Analysis.* Primary Care Companion for CNS Disorders. 13(4): 1000-1068.

Cohen, D., Bloden, L., Rothman, R., Farrar, J., Galantino, M., Volger, S,. Mayor, C., Szapary, P., Townsend, R. 2011. *Iyengar Yoga versus Enhanced Usual Care on Blood Pressure in Patients with Prehypertension to Stage I Hypertension: a Randomized Controlled Trial*. Evidence-Based Complementary and Alternative Medicine. 2011(1): 1-8.

Corcoran, Megan. Viparita Karani. Digital image, black & white. September 2014. La Jolla, CA. Bald Yogi Blog. Accessed 10/4/2015. http://baldyogi.com/give-drink-water-megan-corcoran/

Coulter, HD. 2001. *Anatomy of Hatha Yoga*. Honesdale, PA: Body and Breath.

Center for Disease Control (CDC). 2012. *Treatment Works: Get Help for Depression and Anxiety*. Online. Available: cdc.gov/features/Depression/index.html

Deckro, G., Ballinger, K., Hoyt, M., Wilcher, M., Dusek, G., Myers, P., Greenberg B., Rosenthal, D., and Benson, H. 2002. *The Evaluation of a Mind-Body Intervention to Reduce Psychological Distress and Perceived Stress in College Students*. Journal of American College Health. 50(6): 281-287.

Eisenberg, D., Gollust, S., Golberstein, E., and Hefner, J. 2007. *Prevalence and Correlates of Depression, Anxiety, and Suicidality Among University Students.* American Journal of Orthopsychiatry. 77(4): 534 –542.

Feuerstein, G. 2001. *The Yoga Tradition: its History, Literature, Philosophy and Practice*. Prescott, AZ: Hohm Press. 59-82.

Fishman, L., Groessl, E., and Sherman, K. 2014. *Serial Case Reporting Yoga for Idiopathic and Degenerative Scoliosis.* Global Advances in Health and Medicine. 3(5): 16-21.ge

Isaacs, N. 2007. *The Yoga Therapist Will See You Now*. The New York Times. Available: nytimes.com/2007/05/10/fashion/10Fitness.html?pagewanted=all&_r=0

Iyengar, B. K. S. 1994. *Light on Yoga: The Bible of Modern Yoga—Its Philosophy and Practice—by the World's Foremost Teacher*. New York: Random House, Inc.

Iyengar, B. K. S. 1993. *Light on the Yoga Sutras of Patanjali*. London: Harper Collins. 139-171.

Jerath, R., Edry, J., Barnes, V., and Jerath, V. 2006. *Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system.* Journal of Medical Hypotheses. 67(3): 566–571.

Kaminoff, L., Matthews, A. 2012. *Yoga Anatomy*. Champaign, IL: The Breathe Trust.

Lasater, Judith. 2011. *Relax & Renew: Restful Yoga for Stressful Times*. Berkeley, CA: Rodmell Press.

Long, R. 2008. *The Key Poses of Yoga: Your Guide to Functional Anatomy*. Canada: Bandha Yoga Publications. 165-187.

McCall, T. 2007. *Yoga as Medicine*. New York: Bantham Dell.

McEwen, B., Stellar, E. 1993. *Stress and the Individual: Mechanisms Leading to Disease*. Archives in Internal Medicine. 1993153(18): 2093-2101.

Murugesan, R., Govindarajulu, N., and Bera, T. 2000. *Effect of selected yogic practices on the management of hypertension.* Indian Journal of Physiology and Pharmacology. 44: 207–210.

Narendran, S., Nagarathna, R., Narendran, V., Gunasheela, S., and Nagendra, H. April 2005. *Efficacy of Yoga on Pregnancy Outcome.* The Journal of Alternative and Complementary Medicine. 11(2): 237-244.

Panesar, N., and I. Valachova. 2011. *Yoga and mental health*. Australasian psychiatry: bulletin of Royal Australian and New Zealand College of Psychiatrists. 19(6): 538.

Raub, J. A. 2002. *Psychophysiologic effects of Hatha Yoga on musculoskeletal and cardiopulmonary function: a literature review*. Journal of Alternative Complementary Medicine. 8(6): 797-812.

Santaella, F., Devesa, C., and Rojo, R., Amato, M., Drager, L., Casali, K., Montano, N., and

Geraldo, L. 2011. *Yoga respiratory training improves respiratory function and cardiac sympathovagal balance in elderly subjects: a randomised controlled trial.* BMJ Open. 1(1): 85.

Sherwood, L. 2003. *Human Physiology: From Cells to Systems*. Belmont, CA: Cengage Learning. 304-386.

Tilbrook, H., Cox, H., Hewitt, C,. Kang'ombe, A., Chuang, L., Jayakody, S., Aplin, J., Semlyen, A., Trewhela. A., Watt, I., and Torgerson, D. November 2011. *Yoga for Chronic Low Back Pain: A Randomized Trial.* Annals of Internal Medicine. 155(9): 569-578.

Trinder, J., Kleiman, J., Carrington, M., Smith, S., Breen, S., Tan, N., and Kim, Y. 2001. *Autonomic activity during human sleep as a function of time and sleep stage*. Journal of Sleep Research. 10(4): 253-264.

Yoga Journal. 2012. *New study finds more than 20 million yogis in U.S*. Online. Available: yogajournal.com/uncategorized/new-study-finds-20-million-yogis-u-s/

APPENDIX I

Table 1. *P*-values showing whether the difference between stages of our treatment and control groups were significant. Stages 1-2 compares MAP immediately after the breathing practice. Stages 2-3 compare MAP five minutes after recovering from the breathing practice. Stages 1-3 compare the overall difference. *Asterisk denotes statistically significant results.

Treatment	Stages 1-2	Stages 2-3	Stages 1-3
Pranayama Only	0.023*	1.0	0.024*
Viparita Karani and *Pranayama*	0.0016*	0.035*	0.15