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THE EFFECT OF SURYA NAMASKARA YOGA PRACTICE
ON RESTING HEART RATE AND BLOOD PRESSURE, FLEXIBILITY, UPPER
BODY MUSCLE ENDURANCE, AND PERCEIVED WELL-BEING IN HEALTHY
ADULTS

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THE EFFECT OF SURYA NAMASKARA YOGA PRACTICE ON RESTING HEART
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KRISTINE M. FONDRAN

ABSTRACT

Surya Namaskara (SN) is a yoga practice(routine) that consists of a series of 12 physical postures made up of a variety of forward and backward bends. The series of movements stretch the spinal column and massage, tone and stimulate vital organs through alternately flexing the body forwards and backwards. **Purpose:** The purpose of the study was to determine the effects of a twice daily SN yoga practice on resting heart rate (HR) and blood pressure (BP), flexibility, upper body muscle endurance, and perceived well-being in low to moderately active adult males and females. **Methods:** Participants (24 females, 6 males; mean age 34 years) were randomly assigned to a yoga or control group using the fishbowl technique of random assignment with replacement. After a 3 hour introduction to proper SN techniques, the subjects were directed to perform two SN routines daily for 10 minutes each followed by a 5 minute relaxation period, 5 times per week for a period of 6 weeks. Pre and post measurements were conducted for HR, BP, hamstring flexibility, upper body muscle endurance, and perceived well-being. Inferential statistics with repeated measures (2-way ANOVA) was used to analyze the data. **Results:** A significant increase was found in flexibility with an improvement of 2.9 inches ($p=.000$) and 4.4 push-ups ($p=.003$) after yoga the training program, with little or no change in the control group. **Conclusion:** It can be concluded that SN is effective in increasing hamstring flexibility and improving upper body muscle endurance.

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
CHAPTER	
I. INTRODUCTION.....	1
II. LITERATURE REVIEW.....	5
III. METHODS.....	21
IV. RESULTS AND DISCUSSION.....	31
V. SUMMARY AND CONCLUSION.....	40
BIBLIOGRAPHY.....	44
APPENDICES	
A. INFORMED CONSENT.....	47
B. AHA/ACSM PARTICIPATION QUESTIONNAIRE.....	51
C. SF-36 HEALTH SURVEY.....	53
D. SF-36 US POPULATION NORMS.....	58
E. SURYA NAMASKARA ILLUSTRATIONS.....	60
F. YOGA PRACTICE JOURNAL.....	63

LIST OF TABLES

Table	Page
1. Initial Group Characteristics and Pre-test Results.....	32
2. Changes in Physiological Measures.....	33
3. SF-36 Measures.....	34

LIST OF FIGURES

Figure	Page
1. Sit and Reach Start.....	23
2. Sit and Reach Finish.....	23
3. Prayer Pose.....	24
4. Raised Arm Pose.....	24
5. Hand to Toe Pose (Modified).....	24
6. Equestrian Pose.....	25
7. Mountain Pose.....	25
8. Cow Pose.....	25
9. Cat Pose.....	25
10. Mountain Pose.....	25
11. Equestrian Pose.....	25
12. Hand to Toe Pose (Modified).....	26
13. Raised Arm Pose.....	26
14. Prayer Pose.....	26
15. Shavasana(Corpse Pose).....	26
16. Prayer Pose.....	27
17. Raised Arm Pose.....	27
18. Hand to Toe Pose(Full Version).....	27
19. Equestrian Pose.....	27
20. Mountain Pose.....	27
21. Eight Point Pose.....	27

22. Striking Cobra Pose.....	28
23. Mountain Pose.....	28
24. Equestrian Pose.....	28
25. Hand to Toe Pose(Full).....	28
26. Raised Arm Pose.....	28
27. Prayer Pose.....	28
28. Change in Hamstring Flexibility.....	33
29. Change in Push-ups.....	34

CHAPTER I

INTRODUCTION

Yoga is believed to be 4000 to 8000 years old with its origins in the Indus Valley civilization in the northwestern part of India. ¹ The word yoga, meaning “unity or oneness,” was derived from the Sanskrit word *yuj* which means “to join.” Yoga was first mentioned in Rig Veda, the oldest sacred text of Brahmanism, which formed the basis of modern day Hinduism in approximately 1500 B.C.E. ¹ Before this time, it is believed that yoga techniques were kept secret by the sages and never written down. ² In the Upanishads (800-500 B.C.E.), yoga was thought of as a way of life that would allow an individual to achieve liberation from suffering. ¹ Through subsequent time periods, texts, and teachers, the definition of yoga has expanded to incorporate a wide range of disciplines, philosophies, and practices.

The most prominent and recognizable form of yoga, especially in the Western world, is hatha yoga. ² It is a branch of yoga that concentrates on

physical health and mental well-being. Through practicing various body postures (asana), breathing techniques (pranayama), and meditation, it is believed that one can obtain a sound physical body as well as a calm and peaceful mind.²

Regular practice of a variety of yoga techniques have been shown to lower heart rate and blood pressure in various populations.^{3,8,19} In recent years, it has become more apparent that people need techniques to help them cope with the everyday stressors of modern life. With stress related hypertension and cardiovascular disease on the rise, these hatha yoga techniques may provide a platform for health and well-being. This form of yoga may provide much needed physical and mental therapy.²

Regardless of the testimony of celebrities or the documented physiological benefits of regular yoga or mind-body practices, even the most motivated individuals find it challenging to find time to implement any of the worthwhile yoga techniques available to them. With various organized classes ranging from 45 to 90 minutes in length, it is often difficult to incorporate a daily or weekly yoga practice given the time already appropriated to regular cardiovascular or resistance training routines. Carving time for yoga or flexibility training with a schedule that is already full morning to night is nearly impossible for most people. In most cases, facilitating mind and body flexibility is easily put aside when it is probably needed the most.

However, keeping the body flexible may help decrease tightness and tensions that can lead to chronic and often debilitating physical problems.^{2,4} Once sidelined from regular activities due to orthopedic or other problems, it

becomes increasingly difficult to be motivated to start exercising again.⁵

Regardless of the potential physical risks of inflexibility, even the most dedicated runner or recreational athlete often does not make time for adequate flexibility training.⁶

Since time is often seen as a limiting factor when exercising, a daily practice of Surya Namaskara (salute to the sun) can be the perfect solution for time-challenged individuals.⁷ Surya Namaskara is a series of 12 physical postures made up of a variety of forward and backward bends.⁷ The series of movements stretch the spinal column and upper and lower body through their full range of motion, massaging, toning and stimulating vital organs by alternately flexing the body forwards and backwards.² It builds upper body strength through the inherent weight bearing positions, especially in the arms and shoulders, throughout the series.⁷ The simulated push-up movement and upper body weight bearing positions in the series may help to develop muscular strength and endurance in the pectoral, triceps, as well as the muscles of the trunk.^{7,26} The series gives such a profound stretch to the body that it is considered to be a complete yoga practice by itself.⁴

The purpose of the study was to determine the effects a 6 week, twice daily Surya Namaskara yoga practice(routine) on resting heart rate and blood pressure, upper body muscular endurance, flexibility and perceived well-being in low to moderately active adult males and females.

It was hypothesized that a 6 week, twice daily Surya Namaskara yoga practice will significantly decrease resting heart rate and blood pressure, and

significantly improve flexibility, upper body muscle endurance and perceived well-being.

CHAPTER II

LITERATURE REVIEW

The purpose of the study was to determine the effects of a 6 week, twice daily Surya Namaskara yoga practice on resting heart rate and blood pressure, upper body muscular endurance, flexibility, and perceived well-being in low to moderately active adult males and females. A summary of literature pertinent to this study is discussed in the following sections: heart rate and blood pressure, flexibility and muscle endurance, psychological effects, and intervention adherence.

Heart Rate and Blood Pressure

Telles et al.⁸ conducted a study to determine if novice yoga practitioners would be able to voluntarily reduce their heart rate and whether the magnitude of the reduction would be greater after 30 days of yoga training. There were two groups of healthy subjects, one yoga group and one control group with 12 volunteers in each ranging in age from 20-40 years. The experimental group

consisted of novices who joined a 30 day yoga course and the control group was from an institution close to the yoga center.

After the administration of the EKG for initial heart rate, there was a six minute session during which the participants were asked to voluntarily reduce their heart rate without being given any directions or suggestions on how to do so. During the six minute period, the heart rate was calculated every 30 seconds. The yoga group received 30 days of yoga training. Each daily program was approximately six hours in duration and consisted of various sessions of asana, pranayama (breathing exercises), cleansing practices, meditation, guided relaxation, and yoga theory and philosophy. The control group received no instruction during the 30 day period. The yoga group showed a significant decrease of 5 beats per minute in both their baseline heart rate and the lowest heart rate achieved voluntarily following the 30 day yoga program while the control group showed no change.⁸

McCaffrey et al.³ examined the effectiveness of a yoga program on blood pressure and stress in a group of hypertensive patients in Thailand. There were a total of 35 women and 19 men, average age of 56.3 years, who participated in the study that were all diagnosed with hypertension. Participants were randomly assigned to either the experimental or control group. The Stress Assessment Questionnaire (SAQ) was given to all participants to assess stress levels. Physiologic data included blood pressure, heart rate, and body mass index (BMI). Each participant kept a practice log to indicate that he or she followed the study protocol. The SAQ was administered to all participants prior to and post

intervention and physiological measurements were taken every 2 weeks until the end of the 8-week protocol.

The intervention yoga program used booklets based on yoga principles as well as a cassette tape of yoga guidance to instruct them through a basic yoga practice that included asana (postures) and pranayama (breathing practices). The protocol was to practice yoga for 1 hour three times per week for eight weeks. The control group only received typical outpatient teachings on hypertension, including instruction on diet and exercise.

The experimental group significantly decreased stress scores from 93.6 ± 23.5 to 80.9 ± 13.6 while stress scores for the control group increased from 105.2 ± 35.1 to 106.7 ± 27.5 . These results indicated that eight weeks of practicing yoga decreased mean stress levels. HR and BP decreased significantly in the experimental group at weeks 2, 4, 6 and 8 with mean HR decreasing by 12 bpm; systolic BP decreasing by 24 mmHg and diastolic BP 17 mmHg. It was concluded that yoga practice in Thailand was consistent with cultural philosophy and that practicing yoga asana and pranayama over an eight week period reduces stress, heart rate, and blood pressure among Thai people with mild to moderate hypertension.³

Sivansankaran et al.⁹ conducted a pilot study to assess the effects of yoga on hemodynamic and laboratory parameters of endothelial function in a six-week pilot study. Measurements of systolic and diastolic blood pressure, heart rate, body mass index (BMI), fasting glucose, lipids, C-reactive protein (CRP), and endothelial function were taken at baseline and after 6 weeks of yoga practice.

There were 41 subjects including some with known Coronary Artery Disease (both with and without CAD risk factors) and subjects that were not currently diagnosed with CAD. The six week study consisted of 1.5 hour guided sessions three times per week of asana (yoga postures), pranayama (breathing techniques), and meditation. The subjects were also encouraged to practice at home.

Of the original 41 subjects, 33 participants finished the study with varying degrees of compliance. Results showed a significant reduction in blood pressure, heart rate, and BMI in the total group. There were no significant changes in the various laboratory parameters tested, but significant improvement in endothelial-dependent vasodilatation was seen in 69% of the subjects in the yoga group which was encouraging. Sivansankaran et al. concluded that yoga and meditation appear to improve endothelial function in subjects with CAD.⁹

Blank¹⁰ conducted a study to evaluate acute physiological responses to Hatha yoga postures in the Iyengar tradition which focuses on the structural alignment of the body through the development of asanas (postures).¹² There were 15 female subjects, aged 43.5 ± 6.9 years, intermediate to advanced yoga practitioners who participated in a 90-minute yoga practice where HR, oxygen uptake (VO_2), and BP were monitored throughout the session. The subjects followed a video taped practice that was developed by a certified Iyengar instructor. While practicing along with the video, subjects were told not to struggle in a pose but instead, to come out of the pose and assume a resting

posture. The designated time for each of the 24 postures performed was between one to five minutes.

Heart rate was within 55-85% of the age-predicted maximum. The range for cumulative time spent within this HR zone for all subjects was approximately 11-60 minutes. Heart rate, VO_2 , estimated metabolic equivalents, and O_2 pulse data were determined from an online breath-by-breath open circuitry gas analysis system with a 3-lead EKG. Significant physiological responses were found in standing asanas, inversions, and push up to back arch. Supine and seated asanas did not produce the same results. The average metabolic equivalent (MET) of each pose did not exceed 5 Mets. The practice expended 149.4 ± 50.7 kcal. The cumulative time spent within a HR zone of 55-85% HRmax was 29.7 ± 15.9 min (range = 10.8 – 59.9 min).

Blank¹⁰ concluded that the Iyengar yoga practice was classified as mild to moderate intensity exercise for the practitioners in the study. The cumulative energy expenditure of the 90 minute practice met the current public health guidelines for physical activity which should provide benefits for reduced risk of cardiovascular disease and improved cardiovascular fitness for sedentary adults.¹³ The type of posture performed and the time spent in the posture significantly determined physiological responses. There was also evidence that postural alignment may have relevant physiological consequences for those who practice yoga.¹⁰

Flexibility

Mastangelo et al.¹³ conducted a study to determine the effects of yoga on quality of life and flexibility in menopausal women. Six women, ages 44 years to 62 years, who were not currently active in an organized fitness or wellness program and who were at various stages of menopause participated in the study. The intervention consisted of an eight week yoga program with bi-weekly classes and included a home exercise program. The Menopausal Specific Quality of Life (MSQOL) survey and the sit and reach test for measuring hamstring flexibility were administered at baseline and exit sessions. The Baecke Questionnaire of Habitual Physical Activity was also given to participants at the baseline session.

The yoga protocol was Iyengar yoga based and was designed to help manage many of the menopausal symptoms that women encounter. The home practice sessions consisted of three options, 15-30 minutes in length, which included general practice and symptom-based management with specific postures tailored to relieve various menopausal discomforts. All eight women completed the program with five out of six reporting that they adhered to the home practice sessions as well. Five out of the six participants had a decrease in menopausal symptoms and an increase in quality of life. Flexibility improved in four out of five participants. One participant injured her knee a week before the post test and was unable to perform the sit and reach test. On the post test questionnaire, all six participants reported an increase in their subjective physical flexibility following the eight week intervention. Participants subjectively commented that the yoga was enjoyable and that they had an improvement in

sense of well-being.¹³ Due to small number of subjects in study no statistical results were given.

Psychological Changes

Telles et al.¹⁴ evaluated the efficacy of an ancient yoga text that suggests that a combination of calming and stimulating practices may be especially helpful in reaching a state of mental equilibrium. This experiment aimed to compare the effects of whether a combination of activation and relaxation, known as cyclic meditation (CM), or relaxation alone in the supine position, known as shavasana (SH), would alter metabolic and breath rates in the same or different directions. There were 40 male volunteer subjects, ages 20 to 47 years. Only male volunteers were used because in previous studies, VO_2 and ventilation have been shown to vary during the menstrual cycle at baseline and in response to exercise.¹⁵ All participants were in good health and had been practicing yoga, including the CM and SH techniques, prior to the study. All participants were assessed in both CM and SH. The CM session lasted for approximately 22 minutes. Subjects followed instructions on an audiotape which took them through a series of yoga postures and relaxation periods. The SH session also lasted approximately 22 minutes, and subjects were instructed to lie in the supine position of shavasana with eyes closed. Following both CM and SH, VO_2 was measured with a closed-circuit apparatus. The subjects were told to sit quietly in a chair. There was no instruction on how to breathe and participants were just told to breathe as normally as possible.

A significant difference was found between values recorded before and after the sessions of CM and SH for VO_2 and ventilation. Oxygen consumption decreased by 32.1% after CM compared to 10.1% after SH, breath rate decreased by 18% after CM and 15.2% after SH, and ventilation increased by 28.8% after CM and 15.9% after SH. While CM was more stimulating than SH, the researchers still saw a reduction in VO_2 and changes in respiration, which would suggest relaxation. The findings of the study support the idea that CM, which combines stimulating and calming techniques, when coupled with a background of relaxation and awareness, may reduce physiological arousal better than SH, lying in a supine position, which has also been shown to be calming.¹⁴

Matsumoto and Smith¹⁶ compared the physiological effects of progressive muscle relaxation (PMR) which consists of tensing up the body then relaxing as well as breathing exercises. Forty two undergraduate college students (14 males, 28 females) with an average age of 19.55 years participated in the study. Participants were randomly assigned to either progressive muscle relaxation or deep breathing relaxation. Each group met with the researcher for five weekly, 30 minute sessions. During this time, the participants practiced the assigned exercises while the researcher read the script aloud. All participants took an early version of the Smith Relaxation States Inventory (SRSI)¹⁹ consisting of 25 self-report items. ABC Relaxation Theory states that all approaches to relaxation work when they evoke a special set of healing and renewing psychological states

called “Relaxation States,” or “R-States.”¹⁷ The participants indicated how they currently felt at the present moment using a 6 point Likert scale.

Five weeks of breathing practices or PMR generally did not have differential effects on cognitive or physical stress. However, when looking at the broad range of relaxation states that are proposed in the ABC relaxation theory, important differences were seen. PMR appears to trigger physical relaxation and disengagement, whereas breathing stimulates feelings of strength and awareness. In addition, PMR appears to evoke mental quiet and joy as a delayed aftereffect tested after a break at the end of the study. Overall, the results of the study showed that the ABC approach to relaxation has value and that relaxation has implications that affect higher levels of consciousness.¹⁶

Ghoncheh and Smith¹⁸ attempted to replicate Matsumoto and Smith’s study¹⁷ on the psychological effects of PMR and breathing but this time used PMR vs. yoga stretching (hatha) exercises. There were 40 male and female participants with a mean age of approximately 34 years who were bank customer-service representatives whose job consisted of responding to customer complaints by phone eight hours per day. Participants were randomly assigned to yoga stretching or PMR. Each group met two consecutive days per week for five consecutive weeks and was instructed not to practice at home. The relaxation scripts used in this study employed only one attentional strategy at a time. For example, PMR incorporated only tensing up and relaxing without including breathing, stretching or imagery components which are often included in popular versions of PMR. The yoga stretching focused only on slow stretching.

Each script was approximately 30 minutes in length and targeted the same 11 muscle group combinations.

All participants took the Smith Relaxation States Inventory (SRSI)¹⁹ at various times throughout the testing period. The SRSI consists of 30 self-report items that tap the 15-R-States and 3 stress states; somatic stress, worry, and negative emotion. Over five weeks, a sequence of 12 tests was given which consisted of five pretests, five post-tests; and two additional tests given during the first and last week of the study.

PMR was found to be generally more effective than yoga stretching at evoking the relaxation states of disengagement and physical relaxation, but only after four weeks of training. Joy and mental quiet emerged as aftereffects for PMR after five weeks. The findings showed no difference between PMR and yoga stretching on either R-State Energized or Aware which is inconsistent with previous findings¹⁷ and may suggest Ghoncheh and Smith's version of yoga stretch is less effective than breathing exercises.¹⁸

Netz and Lidor²⁰ conducted a study to compare the efficacy of four different physical activity modes to improve mood after participation in one session of activity on a weekly basis. Fourteen female physical education teachers, aged 24-45 years, were enrolled in a 1 year enrichment program at a physical education and sports sciences college. The four physical activity modes of yoga, Feldendkrais (awareness through movement), swimming, and aerobics were compared to a non-physical activity, a computer class. All groups met in a 90 minute session once a week during the academic year. The following

instruments were used: State and Trait Anxiety Inventory, Depression Adjective Check List (DACL), T-DAC, and L (trait) were used to assess depressive moods, Subjective Well-being Scale, Eysenck Personality Inventory (EPI), and the Lie scale. Baseline testing was conducted at the second class meeting with a post measurement taken at the 14th week of each course. It was concluded that mood improvement was evident after exercise bouts of Feldendrais, swimming, and yoga, but there was no improvement in mood found following aerobic dance or the computer class. It was concluded that mindful low-exertion activity, as well as some aerobic activity, enhanced mood in a single session.²⁰

Wang et al.²¹ examined the effects of Tai Chi on college students' perceptions of their physical and mental health. Thirty undergraduate and graduate college students with a mean age of 24 years who were enrolled in a university Tai Chi class were enrolled in the three month intervention which included two one-hour Tai Chi classes per week. The participants were given the multidimensional SF-36v2 healthy survey questionnaire to measure their physical and mental health pre and post intervention.

The results indicated that Tai Chi can be of assistance in improving both the physical and mental health of college students. Vitality (sense of energy and freedom from fatigue), mental/emotional role function (extent to which health interferes with daily life), and general emotional health (perception of mental health) all improved significantly as measured by the SF-36v2. The results were surprising to the researchers because the sample of participants consisted of healthy graduate and undergraduate students. College students may benefit

from a regular Tai Chi practice as it can be effective in dealing with some of the emotional and psychological stresses that accompany the life experiences of college students.²¹

Lee et al.²² studied the health effects associated with participation in a community-based mind-body training program. Their primary objective was to measure changes in health-related quality of life of the participants after three months of training in dahn-bak (also known as “Brain Respiration”) which originated in South Korea. The practice has elements of hatha yoga and qigong (energy cultivation).

Participants were recruited from eight community-based centers in the metropolitan New York City area. One hundred and ninety four adults with a mean age of 40 years who had taken no more than 10 classes at any one of the centers participated in the study. The SF-36 questionnaire, the Centers for Epidemiologic Studies Depression Scale, the Spielberger Trait Anxiety Inventory, and the Generalized Self –Efficacy Scale were used prior to the onset of training and at the end of the study.

The study participants trained at their respective centers in the same way any new enrollee would train. The dahn-bak method consisted of a 1 hour class 2 to 3 times per week. Each class had 3 phases. The class began with stretching exercises to increase flexibility in the large muscle groups of shoulders, neck, hips, back and knees. The second phase included various postures that were held for longer periods so energy activated from the exercises could accumulate

in the body. This phase was followed by 5-10 minutes of meditation which was intended to facilitate awareness of energy moving within the body.

The results showed that at baseline, new participants to the mind-body training reported lower health-related quality of life in 7 out of 8 domains as compared to other U.S community-based populations. However, after three months of training, the mind-body participants reported significant improvements in all domains of health-related quality of life, fewer depressive symptoms, less trait anxiety, and greater self-efficacy. Participants who had reported lower health-related quality of life at baseline reported moderate improvements after the intervention. These findings suggested that participation in mind-body classes could possibly be a means to which some participants may attain moderate but clinically significant improvements in perceived health-related quality of life.²²

Waelde et al.²³ conducted a pilot study to determine if an intervention of yoga and mediation would be beneficial in alleviating stress for those who care for a family member with dementia. Twelve older female dementia patient family caregivers participated in a 6 session yoga and mediation program which was designed to help dementia caregivers deal with stress. The program, called Inner Resources, consisted of six weekly sessions: five 90 minute sessions and one 3-hour session. The sessions included instruction and group practice in meditation, hatha yoga, breathing techniques, guided imagery, and mantra repetition. Caregivers were asked to practice some of these techniques for at

least 30 minutes per day 6 days per week and were given two audiocassettes recorded for the study and a manual for home practice.

Depression was assessed by using the Center for Epidemiological Studies Depression Scale; self-efficacy was determined by using the Self-Efficacy for Controlling Upsetting Thoughts About Care Giving subscale of the Revised Scale for Care Giving Self-Efficacy; Anxiety was assessed with the State-Trait Anxiety Inventory; Craving Burden was determined by administering the Revised Memory and Behavior Problem Checklist; Treatment Adherence was measured by a weekly practice log of how long participants engaged in the practice of yoga- meditation techniques during each week. All measurements were given one week pre-intervention and one month post-treatment. The findings of this study indicated that a yoga-meditation intervention significantly reduced depression and anxiety and increased self-efficacy in chronically stressed women who are primary caregivers of a person with dementia.²³

Intervention Adherence

Flegal et al.²⁴ conducted a study to determine the adherence to mind-body intervention in a randomized trial. One hundred thirty five healthy men and women, 65-85 years of age, were enrolled in this six month study. The subjects were randomized into a yoga class with home practice, an exercise class with home practice, or a wait-list control group. The yoga subjects attended a once a week, 90 minute class. Subjects in the exercise class engaged in aerobic walking on an outdoor track for one hour per week. Both groups were strongly encouraged to partake in independent practices 5 times per week, working at the

same perceived exertion level as during the organized class. All subjects were assessed at baseline and at 6 months to determine study outcomes. Outcome measures included cognitive function measured by the Center for Epidemiologic Studies Depression Scale (CES-D-10) and Profile of Mood States (POMS). Fatigue was assessed using the Multidimensional Fatigue Inventory (MFI-20) and anxiety by the State and Trait Anxiety Index (STAI). Health-related quality of life was measured with the SF36. Flexibility and balance were measured with the sit and reach test and one legged standing test, respectively. Adherence to each intervention was measured by class attendance and home practice logs.

One hundred eighteen out of the 135 original subjects completed the study. Attrition in the groups was 14% for yoga, 19% for exercise and 5% for control which was not significantly different. Attendance for the yoga and exercise groups was 77% and 69% respectively, with home exercise practice occurring 64% of the days for the yoga group and 54% for the exercise group. Class attendance was significantly correlated with several baseline measures including mood, physical aspects of quality of life, and measures of fatigue. Higher measures of depression at baseline were associated with lower class attendance. There was a positive relationship between adherence and perceived physical functioning, general health, vitality, and vigor at baseline. The yoga group showed significant improvement in the self-rated measures of physical functioning and general health as scored by the SF-36 compared to the exercise and control groups.

The researchers found that adherence to behavioral treatments such as yoga and exercise was significantly correlated with baseline variables including depression, fatigue, and physical aspects of quality of life. Adherence did not seem to affect the significant study outcomes of quality of life and physical measures. However, baseline measures of depression, fatigue, and physical components of health-related quality of life were significantly correlated with adherence. It was concluded that healthy seniors will reasonably attend physical activity interventions.²⁴

Summary

The studies reviewed illustrate that there are many physical, physiological, and psychological benefits of participating in yoga and related mind-body interventions. These studies show that regardless of current health status, mind-body interventions can be successful in improving the health and wellness status of a variety of individuals. The results are encouraging as they show alternate ways to improve overall physical health and mental well-being which may be considered as a compliment to traditional medical interventions.

CHAPTER III

METHODS

The research design was experimental. The independent variable was the intervention of Surya Namaskara (salute to the sun) 24 pose yoga practice. Dependent variables were resting heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP), hamstring flexibility, upper body muscular endurance, and perceived well-being. The latter included domains of physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (V), social function (SF), role-emotional (RE) and mental health (MH). Delimitations were; age 20-55 years, current exercise of no more than 3 times per week for no more than 1 hour, normal resting blood pressure, and non-pregnant. In addition, the volunteers could not have had a regular flexibility training routine and could have only minimal previous exposure to mind-body or yoga-related classes prior to the onset of the study.

Subjects

Thirty men and women (n=24 females, n=6 males, ages 21 to 51 years, were recruited from Cleveland State University students, faculty and staff, as well as the community at large to participate in a 6 week yoga study. Volunteers were excluded if they had participated in regular mind-body related classes in the past, had a regular group or self-stretching routine, were diagnosed as hypertensive, or if they were pregnant.

Subjects were randomly assigned to either a yoga or control group using the fishbowl technique of random assignment with replacement.²⁸ Groups were stratified by gender to ensure gender equality with each group. Each participant signed an informed consent form (Appendix A) and completed the American Heart Association and American College of Sports Medicine Pre Participation Screening Questionnaire (Appendix B) prior to the onset of the study. Both groups were given an oral and written overview of the study and all participants agreed to participate in the study regardless of being selected for the yoga or control group. Those assigned to the control group were provided a session of yoga instruction and video of the yoga intervention practice at the conclusion of the study.

Procedures

Prior to testing, the subjects were weighed using a physician's beam scale, and height was measured using a wall-mounted stadiometer. A Polar heart monitor was used to measure resting heart rate. The researcher, using a

standard sphygmomanometer and stethoscope, manually measured the subjects' resting blood pressure during the pre and post study testing. Hamstring flexibility was measured using a standard sit and reach box (Figures 1 & 2).⁶



Figure 1. Sit and Reach Start



Figure 2. Sit and Reach Finish

Upper body muscle endurance, particularly that of the triceps, anterior deltoids, and pectoralis, was measured by a standard push up test where the number of correctly performed push-ups IS counted until exhaustion or form is lost.⁷ Males performed traditional push-ups while females performed modified push-ups.⁷

The SF-36v2 (Appendix C) along with U.S. population norms (Appendix D) were used to measure perceived well-being.²⁷ The SF-36v2 includes one multi-item scale that assesses eight health concepts: 1.) limitations in physical activities because of health problems(PF), 2) limitations in usual role activities because of physical health problems (RP), 3) bodily pain (BP), 4) general health perceptions (GH), 5) vitality (energy and fatigue) (V), 6) limitations in social activities because of physical or emotional problems (SF), 7) limitations in usual role activities because of emotional problems (RE), 8) general mental health (psychological distress and well-being) (MH). Evidence of construct validity and

reliability is acceptable on the variables of age, gender and socio-economic class.²⁷

All physical and psychological measures were repeated at the conclusion of the intervention.

Intervention Procedures

After the pre-test, the intervention group was given one, 1.5 hour session of instruction to learn the basic postures of the modified version of Surya Namaskara (Figures 3-15). After the initial instruction period, the group was instructed to perform the routine two times daily for 10 minutes followed by a 5 minute rest period of lying on their backs in shavasana (Figure 15). Subjects were instructed to following their natural breath. Following the natural breath is done by paying attention to each inhalation and exhalation for the period of time indicated. When performing the routine, subjects were instructed to hold each posture for the duration of one inhalation or exhalation depending on the movement being performed.



Figure 3. Prayer Pose



Figure 4. Raised Arm Pose



Figure 5. Hand to Toe Pose (Modified)



Figure 6. Equestrian Pose



Figure 7. Mountain Pose



Figure 8. Cow Pose



Figure 9. Cat Pose



Figure 10. Mountain Pose



Figure 11. Equestrian Pose



Figure 12. Hand to Toe Pose (Modified)



Figure 13. Raised Arm Pose

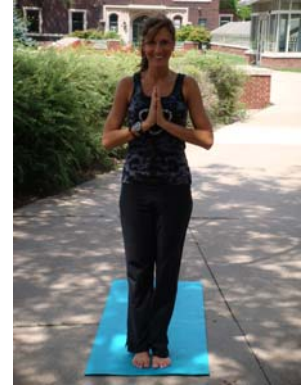


Figure 14. Prayer Pose



Figure 15. Shavasana (Corpse Pose)

In the third week of the study, the intervention group met with the researcher for a 1.5 hour session to learn the full version of Surya Namaskara (Figures 16-27) Both versions are comparable in regard to the movement of the body, but the modified version allowed the participants to gradually become accustomed to the routine. Performing the modified version for the first three weeks allowed the intervention group to acquire the necessary skill set to avoid injury and to gradually develop agility and endurance before attempting the more demanding full version.



Figure 16. Prayer Pose



Figure 17. Raised Arm Pose



Figure 18. Hand to Toe Full Pose (Full Version)



Figure 19. Equestrian Pose



Figure 20. Mountain Pose



Figure 21. 8-Point Pose



Figure 22. Striking Cobra Pose



Figure 23. Mountain Pose



Figure 24. Equestrian Pose



Figure 25. Hand To Toe Pose (Full Version)



Figure 26. Raised Arm Pose



Figure 27. Prayer Pose

To facilitate understanding of the routine, the subjects were given access to an internet video of both Surya Namaskara versions being performed by a

certified yoga instructor as well as written instructions and illustrations of each posture (Appendix D). The subjects were given a Yoga Practice Journal in which to record their practice time, to indicate compliance to study protocol, and to alert the researcher to any problems encountered during the study period (Appendix E).

The subjects were directed to perform two Surya Namaskara routines daily, once upon waking and once before dinner five times per week for six weeks. Each routine consisted of eight rounds of practice followed by a five minute rest period where they were to lie still in a supine position (shavasana) and to follow their natural breath. The entire self directed yoga practice took approximately 15 minutes to complete. Throughout the six week self-directed portion of the study, the researcher emailed the participants weekly to ensure that they were continuing compliance with the daily yoga routines and to obtain an electronic copy of their weekly Yoga Practice Journal. Both the yoga and control groups were instructed to continue aerobic exercise at their current level. The yoga group was instructed to refrain from any additional flexibility and strength training above and beyond the Surya Namaskara routine, and the control group was discouraged from participating in any flexibility and strength training for the duration of the study.

Data Analysis

Descriptive statistics were obtained on all measures. An independent t-test was conducted to ensure that the groups did not differ significantly at the onset of the study. Inferential statistics with repeated measures (2-way ANOVA)

assessed differences due to the effect of a daily Surya Namaskara yoga practice on resting heart rate and blood pressure, flexibility, upper body muscular endurance, and well-being. SPSS 14.0 was used for all analyses with .05 used as the level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

Thirty subjects were pre-tested and assigned to the yoga intervention (N=15) or control group (N=15). Three (20%) of the 15 subjects in the yoga group dropped out due to the demands of the study and one (6%) of the 15 subjects in the control group was unable to be reached for post testing. The remaining twenty six subjects, 21 females (38±11.7 years) and 5 males (39.0±96 years) returned for post-testing. Self-reported data from the weekly journals of the yoga group showed a compliance rate of 88.1%. All control group subjects reported that they adhered to the study protocol and stayed within the parameters of exercising no more than three times per week for 1 hour and refrained from flexibility and strength training during the 6 week study period.

As shown in Table 1, no significant initial differences between groups was found for any of the dependent variables, with the exception of weight. The

Table 1. Initial Group Characteristics and Pre-test Results (Mean±SD)

		(Mean±SD)	Range	Sig.
Age (years)	Control (N=14) Yoga (N=12)	40.9±9.219 36.2±10.461	24-53 21-50	.408
Height (cm)	Control (N=14) Yoga (N=12)	170.4±10.3 169.3±7.2	154.9-185.4 160.0-188.0	.915
Weight (kg)	Control (N=14) Yoga (N=12)	78.4±21.8 64.2±9.26	52.3-127.7 54.0-90.7	.016*
RHR (mmHg)	Control (N=14) Yoga (N=12)	71.4±11.7 70.5±7.3	60-89 58-103	.809
SBP (mmHg)	Control (N=14) Yoga (N=12)	115.1±12.9 110.0±8.3	98-136 92-120	.354
DBP (mmHg)	Control (N=14) Yoga (N=12)	71.0±8.4 70.5±11.6	54-84 58-88	.298
Flexibility (in)	Control (N=14) Yoga (N=12)	9.3±3.9 10.5±4.0	1.0-14.8 4.0-15.8	.441
Upper Body Endurance (reps)	Control (N=14) Yoga (N=12)	22.9±10.3 20.8±12.4	6-39 5-52	.632
Physical Function (PF)	Control (N=14) Yoga (N=12)	51.2±8.8 54.4±2.6	25.5-57.0 50.7-57.0	.352
Role Physical (RP)	Control (N=14) Yoga (N=12)	53.8±3.9 55.2±2.4	47.1-56.9 51.9-56.9	.348
Bodily Pain(BP)	Control (N=14) Yoga (N=12)	56.4±6.6 52.6±8.5	46.1-62.1 41.4-62.1	.254
General Health (GH)	Control (N=14) Yoga (N=12)	52.5±8.2 53.3±6.3	30.5-61.1 37.9-60.1	.804
Vitality (V)	Control (N=14) Yoga (N=12)	52.9±7.7 50.5±9.7	36.5-64.6 39.6-67.7	.557
Social Function (SF)	Control (N=14) Yoga (N=12)	54.1±6.8 53.7±6.8	45.9-56.9 45.9-56.9	.878
Role Emotional (RE)	Control (N=14) Yoga (N=12)	51.7±5.9 51.3±5.7	40.3-55.8 40.3±55.9	.862
Mental Health (MH)	Control (N=14) Yoga (N=12)	51.9±4.7 47.2±8.5	44.4-61.3 33.1-64.1	.130

*Significant difference ($p < .05$)

control group weighed significantly more ($p = .016$) than the yoga group (mean = 78.4 kg vs. 64.2 kg). Despite randomization of subjects, two women in the control group were extremely obese weighing 103.4 kg and 127.5 kg, respectively, which explained the initial group difference in weight.

Results of the intervention are shown in Table 2. No significant changes were found for RHR, SBP and DBP. However, a significant difference was found for hamstring flexibility and upper body muscle endurance with no change in the control group but significant increases of 2.9 inches ($p=.001$) in flexibility and 4.4 push-ups ($p=.003$) for the yoga group.

Table 2. Change In Physiological Measures (Mean±SD)

Variable	Control Group Pre (Mean±SD)	Control Group Post (Mean±SD)	Yoga Group Pre (Mean±SD)	Yoga Group Post (Mean±SD)	Sig.
RHR (bpm)	67.0±20.6	72.0±10.2	70.5±11.7	69.2±11.7	.671
SBP (mmHg)	115.9±12.1	112.0±14.2	110.0±8.3	108.3±12.8	.649
DBP (mmHg)	71.1±7.8	73.0±7.6	67.7±8.1	71.0±7.1	.607
Flex (in)	9.4±3.7	9.8±3.9	10.5±4.0	13.4±3.0*	.001*
Upper Body Muscle Endurance (#)	21.2±10.5	20.3±10.4	20.8±12.4	25.2±11.7*	.003*

*Significant increase in yoga group. ($p<.05$)

Figures 28 and 29 illustrate the significant improvement of both hamstring flexibility and upper body muscle endurance in the yoga group.

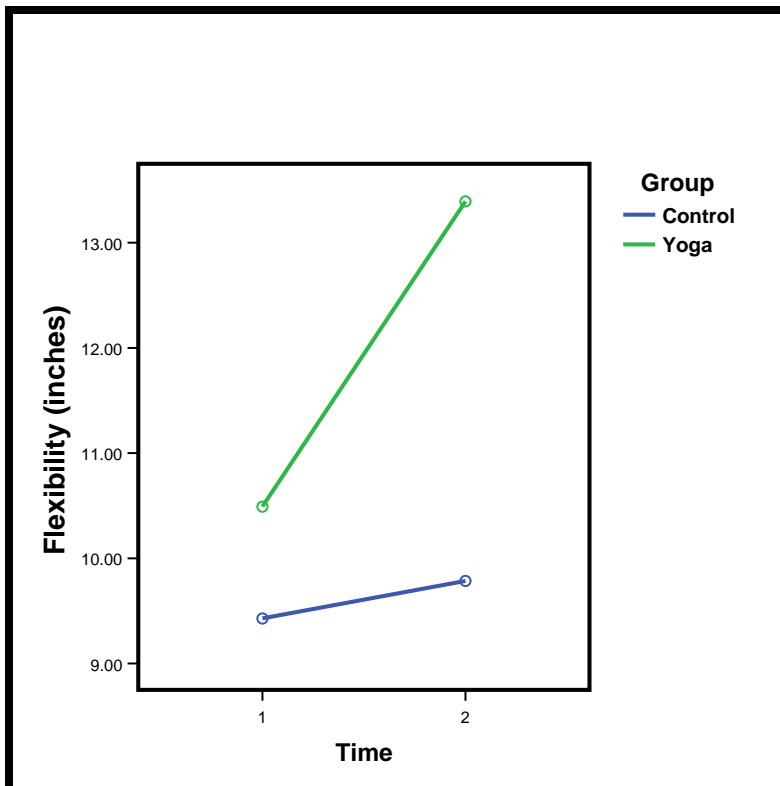


Figure 28. Change in Hamstring Flexibility

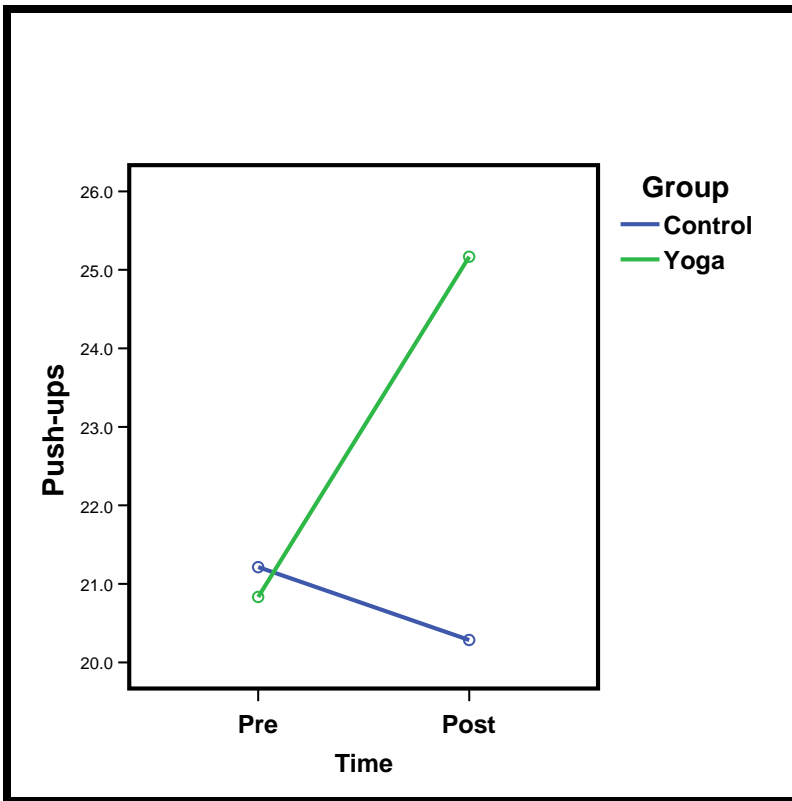


Figure 29. Change In Push-ups

No difference was found in any of the perceived well-being subcategories, PF, RP, BP, GH, V, SF, RE, and MH of the SF-36 as shown in Table 3.

Table 3. Change In SF-36 Measures (Mean±SD)

Variable	Control Group Pre (Mean±SD)	Control Group Post (Mean±SD)	Yoga Group Pre (Mean±SD)	Yoga Group Post (Mean±SD)	Sig.
Physical Function (PF)	51.9±8.2	54.8±3.1	54.4±2.6	55.1±2.3	.394
Role Physical (RP)	54.1±3.7	53.3±4.4	55.2±2.4	55.2±3.0	.667
Bodily Pain (BP)	56.4±6.4	56.1±6.4	52.6±8.5	54.3±6.4	.544
General Health (GH)	52.8±7.9	55.4±6.0	53.3±6.3	57.7±5.3	.369
Vitality (V)	52.1±7.5	54.9±5.7	50.5±9.7	55.7±6.8	.441
Role Emotional (RE)	51.7±5.6	51.4±5.0	51.3±5.7	52.3±4.8	.619
Social Function(SF)	53.7±6.7	52.9±8.9	53.7±6.8	53.2±4.8	.895
Mental Health (MH)	51.0±4.9	52.8±6.2	47.2±8.5	52.6±6.41	.154

Discussion

No study was found that has investigated the efficacy of an abbreviated yoga practice to positively influence changes in physiological and psychological responses. While the outcomes of a twice daily Surya Namaskara (SN) yoga practice partially affirmed the research hypothesis (i.e. improved flexibility and strength), the intervention fell short of affirming some of the physiological and psychological benefits shown in previously discussed mind-body interventions.^{3,8,9,10,13,14,20,21,23}

Unlike Telles et al.⁸ who found a reduction in resting heart rate when a yoga training program was implemented and participants were trained specifically on how to lower their resting heart rate, no differences was found in resting heart rate with the yoga intervention in the current study. Sivansankaran et al.⁹ who studied the effects of a six week intervention of yoga on subjects with coronary artery disease (CAD) also found significant reductions in heart rate from baseline measurements. While the intervention of SN in this study did not significantly reduce RHR, it is possible that adding heart rate awareness as in the Telles et al.⁸ study might possibly have proven beneficial.

In addition, after reviewing the yoga group journals, it was observed that most participants found the 5 minute breath awareness activity after the SN routine to be difficult. There were many comments on how lying still for 5 minutes was “boring” and that many were “anxious” to get on with their daily activities. This portion of the study was most similar to Telles et al. as it simulated the protocol for voluntarily lowering heart rate.⁸ Since there were

multiple journal comments on the difficulty of lying still for 5 minutes, it might be inferred that the mind-set of true relaxation after the rigors of the SN routine was not there and thus did not influence resting heart rate. In addition, unlike McCaffrey et al.³ and Sivansankaran et al.,⁹ where a majority of participants were diagnosed and were being treated for varying degrees of high blood pressure and CAD, the cohort in this study was identified as clinically healthy.^{3,9} Without a compromised cardiovascular system and no pharmacological dependency, the current study group may therefore be less likely to show significant changes in resting heart rate due to their recorded “normal” baseline values.

In the current study, there was no significant reduction in blood pressure found with the SN intervention. This contrasts with the findings of McCaffrey et al.³ who examined the effectiveness of an 8 week yoga program in a group of hypertensive patients in Thailand, as well as Blank¹⁰ who studied the physiological responses to Iyengar Yoga, as performed by trained practitioners, and found a significant decrease in blood pressure. As already noted for heart rate, significant decreases in blood pressure would also be less likely to occur in absence of disease or a compromised cardiovascular system. In addition, one of the exclusion factors for current study participation was a diagnosis at baseline or current treatment of hypertension. It is then not surprising to see little or no change in blood pressure as it is difficult to make what is considered normal blood pressure “more normal.”

Hamstring flexibility improved significantly (~ 3in) for the SN intervention group. These results are encouraging in regard to the ability of SN to increase

hamstring and lower back flexibility as measured by the sit and reach test.²⁵ Mastangelo et al.,³⁴ who also used the sit and reach test for measurement of hamstring flexibility, found a significant increase in hamstring flexibility with their yoga intervention group as well.¹³ It was also noted that prior to the onset of the study, a majority of participants lamented their lack of hamstring flexibility and many also reported associated lower back stiffness. Amongst the participants, there was recognition of the importance of flexibility training in maintaining lower back health, but all reported that they made little or no effort to improve flexibility prior to study admission. Since hamstring and low back flexibility, along with abdominal strength and endurance, have been shown to play an important role in maintaining a healthy back, the results of the SN intervention suggests that inclusion of SN in an exercise program may help prevent orthopedic disorders associated with limited hamstring and low back flexibility.²⁵

The increased number of push-ups by the yoga group after the intervention of SN was a highlight of the study. Noting the inherent push-up type position that is performed mid-way through the routine (Figure 21), it can be concluded that Surya Namaskara may promote increased upper-body muscular endurance. For those who have limited time for strength training or avoid it all together, the muscle endurance improvements found in this study would be a good argument for performing the routine on a regular basis. In addition, since the simulated push-up portion of the routine specifically works the triceps and serratus anterior muscles, prolonged practice of SN may improve muscle

strength and endurance.²⁶ Surya Namaskara may be especially beneficial for older adults as strength decreases with age.⁶

There was no significant difference observed for any of the dimensions of the SF-36 health survey among the participants. However, the over-all range of scores for both the control and yoga group were in line with what is expected for the general population in the U.S. (Appendix D).⁷ These results are in contrast to Lee et al.²² who were able to show improvement in health-related quality of life when participants were introduced to various mind-body related classes. The duration of Lee et al.'s study, which was conducted over a three month period, may have been an important factor leading to the study's success.

Of all the dimensions covered in the SF-36, improvement in mental health, while not significant, showed a trend ($p=.154$) in the yoga group. After speaking with many subjects in the yoga group and reviewing their weekly journals, it was observed that many attributed improvement in over-all well-being and physical mobility to adherence to the Surya Namaskara routine. A few subjects expressed that they felt the forward and backward flexion, which is a main component to the routine, had notably assisted in decreased lower back stiffness that they arbitrarily felt throughout the day. Examples of anecdotal comments included:

“Painful back stiffness is decreasing as I continue with the routine.”

“My neck has bothered me in the morning for years and that pain has substantially subsided.”

After the routine I always feel good and stretched out... aligned... kind of hard to explain, everything just feels in order.”

Unfortunately these and other positive remarks are not reflected in the SF-36 scores. In general, the SF-36 health survey scores were equal to or slightly less than that of Wang et al.²¹ who used the same instrument to study mental health changes of college students who took part in a Tai Chi intervention over a 3 month period. Although there was no significant improvement found in any of the domains in the current study, it is surmised by the journal comments of the SN intervention group, just as in Wang et al., that the mind-body practices of yoga may help in dealing with emotional and psychological stressors of everyday life.²¹

CHAPTER VI

SUMMARY AND CONCLUSION

Summary

The purpose of the study was to determine the effects of a 6 week, twice daily Surya Namaskara (salute to the sun) yoga practice on resting heart rate and blood pressure, flexibility, upper body muscular endurance, and perceived well-being in low to moderately active adult males and females. The results of this study have shown that performing a twice daily yoga routine of Surya Namaskara can positively influence flexibility in the hamstring muscles as well as improve upper body muscle endurance. Other mind-body interventions have found significant changes in resting heart rate and blood pressure, and perceived well being in subjects with hypertension and other health issues. Given that participants in this study had normal baseline measurements for these variables, it is not surprising that “normal” does not become “more normal”. The results of this study imply that individuals who are seeking to increase flexibility and muscle

endurance may be able to do so with a short, twice daily Surya Namaskara practice.

Conclusion

The Surya Namaskara yoga series is a unique form of yoga as it integrates physical and mental aspects of the body through a series of low impact movements. This study is the first of its kind to assess the effects of short duration yoga practices and showed significant effects on increasing flexibility and upper body muscle endurance after a 6 week intervention. Individuals may greatly benefit from a regular, short duration routine of Surya Namaskara as it may prove helpful in relieving muscle stiffness in the back and legs which often contributes to low back pain. The additional benefit of increased upper body muscle endurance is also important especially with inevitable age-related strength decreases.

While there were no significant changes in resting heart rate and blood pressure, or perceived well-being scores in this study, a daily Surya Namaskara practice may be helpful over a longer period of time in maintaining optimum physical and mental health. Regular Surya Namaskara practice has been shown to dissipate or lesson various physical and physiological stressors while improving overall mental health.⁷ With increasingly busy schedules and lack of available time in the day to study, work, exercise, and socialize, perhaps universities, corporate wellness centers, and recreational venues might offer classes on the Surya Namaskara series, making these seemingly beneficial and self- directed techniques available to the community at large.

Limitations

The small sample size and unequal number of participants in regard to gender in both the experimental and control groups were limitations to the study. Larger study samples, if representative of the population, would allow the researcher to generalize the results to the population at large.

The exclusion of participants who had any past or current cardiovascular maladies could directly contribute to the lack of improvement found in resting heart rate and blood pressure. Many of the participants had relatively low heart rates at baseline which may explain why the intervention had no effect on that variable. Also, considering that one of the major delimitations of the study was excluding subjects with hypertension or medicinally controlled hypertension, it is also not surprising to see that there was no significant effect on blood pressure as all participants were within the normal range for blood pressure at baseline.

Martin et al.²⁵ reported that the sit and reach box does not take into account arm and leg length differences and these variations could contribute to higher scores regardless of actual degree of hamstring and lower back flexibility.²⁵ This study did not correct flexibility measurements for arm and leg length.

The lack of improvement in the SF-36 scores could be attributed to the fact that all participants were basically active, healthy individuals at the onset of the study. The fact that the median scores for all categories measured near to or above the U.S. population norms for the SF-36(Appendix D) at the onset of the study, it is fair to say the group as a whole had an above average sense of

perceived well being.²⁷ While there may have been subtle improvements in various categories, the SF-36 was not able to detect this.

Finally, since the twice daily SN practice was self-reported, there may have been bias in under or over-representation of compliance which may have also affected the results. Flegal et al.²⁴ found that attendance in the mind body intervention classes by their subjects was significantly correlated with baseline measures of fatigue, mood, depression and perceived well-being. Those subjects who had lower scores in these variables missed class more often. Since this study did not require class attendance, but was instead self-directed, compliance could not be directly measured.

Future Research

It is suggested that future research be conducted on the effects of Surya Namaskara yoga series on medication-controlled hypertensive populations to examine if blood pressure can be lowered to the point where medication could be discontinued or dose reduced. SN is contraindicated for uncontrolled hypertension so it would be imperative for the safety of participants that blood pressure is under control.⁷ Flexibility testing of additional joint areas such as the hip and low back is also suggested. Given the improvement seen in hamstring flexibility it is possible there might be positive changes in the hip and low back as well, as they are directly affected by the fundamental postures of Surya Namaskara. The increase in upper body strength found in this study suggest that testing of the core muscle groups of the abdomen, the lower body muscle groups such as the quadriceps, is warranted.

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APPENDIX A

Yoga Study-Informed Consent

Purpose of Yoga Study:

You have been asked to participate in a yoga-related study to be conducted in the Human Performance Laboratory at Cleveland State University. The purpose of this study is to measure the effects and benefits of a six-week, 5 days per week, twice-daily, 15-minute self-directed yoga practice on resting heart rate, and blood pressure, flexibility, muscular strength and endurance, and perceived well-being in healthy adults.

Previous studies have documented the physiological benefits of regular yoga or mind-body practices. However, many of these studies called for participants to engage in multiple hours of daily practice over an extended period of time. Since time is often seen as a limiting factor when exercising in general, the significance of this study is that a shortened, twice a day yoga practice may show similar physiological benefits as one of longer duration.

Procedures:

Study participants must be healthy, non-pregnant, non-hypertensive (blood pressure at or below 139/89) individuals between the age of 20-55 years with no prior yoga training and exercise at no more than a low to moderate level (3X per week or less).

As a study participant you will be randomly assigned to an intervention (yoga) or control group. To be included in the study you must agree to participate regardless of being selected for the yoga or control group.

Pre and post measurements will be conducted on all participants regardless of intervention or control assignment. Measurement of resting heart rate will be done with a Polar heart rate monitor. Resting blood pressure will be measured with a stethoscope and sphygmomanometer. Muscle strength and endurance will be measured with a standard push-up test. Flexibility will be measured with a sit and reach box. Perceived well-being will be measured with the SF-36 survey.

Intervention Group (yoga):

If selected as an intervention subject you will attend three, 1.5 hour training sessions that will be administered by a certified yoga instructor to learn the specific yoga routine. After the initial training sessions, a self-directed, 5 days per week, twice daily, 15-minute yoga routine for 6 weeks will commence. The routine consists of various forward and backward bending movements followed by lying in a supine position for a total time of approximately 30 minutes per day.

For additional instructional purposes, the intervention group will be given a DVD of a certified yoga instructor performing the yoga routine, which can be used to follow along when performing the twice-daily routines. In addition, a CD or mp3 download of the instructor verbally explaining the routine as well as written instructions with illustrations of each posture will be provided for additional reference.

For the duration of the study, the intervention group will provide a weekly journal (electronic or hard-copy) of their practice experience to the researcher. This journal will help to notify the researcher of any discomforts or concerns you may have which will allow for modified movements to be substituted until discomforts subside, a discontinuation of the routine for a set period of time or an indefinite discontinuation if necessary.

Control Group:

If selected as a control subject you are asked to participate in pre and post-testing only and to go on with your regular activities of daily living and exercise regime without adding any yoga or flexibility training for the period of the study. On completion of the study you will receive a free yoga mat and DVD of yoga instruction.

Risks/Discomforts:

Every effort will be made to minimize any risks to you by evaluation of preliminary information relating to your health and fitness that you provided by completing the American Heart Association (AHA)/American College of Sport Medicine (ACSM) Pre-participation Screening Questionnaire as well as by careful observation during the pretest period.

There is a possibility of muscle soreness due to the stretching and activation of muscles from the yoga movements inherent in the intervention. The training sessions prior to the onset of the study will help to minimize this soreness by teaching proper movement techniques as well as the reference DVD, CD, MP3 and illustrations and written instructions provided.

Responsibility of the Participant:

Information you possess about your health status or previous symptoms with physical effort may affect the safety of your participation. You are responsible for fully disclosing your medical history, prescription medications, and previous symptoms with physical effort, as well as symptoms that may occur during the pre-test, post-test or intervention period.

Potential Benefits:

The benefits of participation are an increase in daily physical activity for the intervention group as well as the possibility of lowering resting heart rate and blood pressure and

increasing muscle strength and endurance, increasing flexibility, and improving perceived well-being.

Confidentiality:

Any information obtained during the study will be treated as confidential and will not be revealed to any individual without your consent. However, information obtained during the study may be used for research purposes with your right to privacy retained.

Freedom of Consent:

You understand that participation in this study is voluntary and that you have the right to withdraw at anytime with no consequences.

Inquiries:

Any questions about the procedures used in this project are welcomed. If you have any doubts or questions please ask for further explanation or call Kristine Fondran at 216-272-7430 or Kathleen Little at 216-687-4877.

Patient Acknowledgement:

The procedures, purposes, known discomforts and risks, and possible benefits to me and to others have been explained to me. I have read the consent form or it has been read to me and I understand it. Having had an opportunity to ask questions that have been answered to my satisfaction, I voluntarily consent to participate in this study and I have been given a copy of this consent form.

I understand that if I have any questions about my rights as a research subject I can contact the CSU Institutional Review Board at 216-687-3630.

_____	_____
Signature	Date
_____	_____
Witness	Date

APPENDIX B

NAME _____

DATE _____

AHA/ACSM Preparticipation Screening Questionnaire (AHA/ACSM, 1998)¹

Assess Your Health Needs by Marking All true Statements

History

You have had:

- A heart attack
- Heart surgery
- Cardiac catheterization
- Coronary angioplasty (PTCA)
- Pacemaker/implantable cardiac
- Defibrillator/rhythm disturbance
- Heart valve disease
- Heart failure
- Heart transplantation
- Congenital heart disease

Other health issues:

- You have musculoskeletal problems. Specify on back*
- You have concerns about the safety of exercise. Specify on back*
- You take prescription medication(s). Specify on back*
- You are pregnant.

Symptoms

- You experience chest discomfort with exertion.
- You experience unreasonable breathlessness.
- You experience dizziness, fainting, blackouts.
- You take heart medications.

Cardiovascular risk factors

- You are a man older than 45 years.
- You are a woman older than 55 years or you have had a hysterectomy or you are postmenopausal.
- You smoke.
- Your blood pressure is greater than 140/90 mm Hg.
- You don't know your blood pressure.
- You take blood pressure medication.
- Your blood cholesterol level is > 240 mg/dl.
- You don't know your cholesterol level.
- You have a blood relative who had a heart attack before age 55 (father/brother) or 65 (mother/sister).
- You are diabetic or take medicine to control your blood sugar.
- You are physically inactive (i.e., you get less than 30 minutes of physical activity on at least 3 days/week).
- You are more than 20 pounds overweight.
- None of the above is true.

Recommendations

If you marked any of the statements in this section, consult your healthcare provider before engaging in exercise. You may need to use a facility with a medically qualified staff.

If you marked two or more of the statements in this section, you should consult your healthcare provider before engaging in exercise. You might benefit by using a facility with a professionally qualified exercise staff to guide your exercise program.

You should be able to exercise safely without consulting your healthcare provider in almost any facility that meets your exercise program needs.

¹ Proceed with test if musculoskeletal problems are minor, concerns about safety of exercise are normal, and prescription medications are not for cardiac, pulmonary, or metabolic diseases.

RISK STATUS (Low; Moderate; High): _____

APPENDIX C

The SF-36v2™ Health Survey

Name: _____ Date: _____

Instructions for Completing the Questionnaire

Please answer every question. Some questions may look like others, but each one is different. Please take the time to read and answer each question carefully by marking your response.

1. In general, would you say your health is:

- Excellent
- Very Good
- Good
- Fair
- Poor

2. Compared to one year ago, how would you rate your health in general now?

- Much better now than one year ago
- Somewhat better now than one year ago
- About the same as one year ago
- Somewhat worse than one year ago
- Much worse than one year ago

3. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all
a) <u>Vigorous activities</u> such as running, lifting heavy objects, participating in strenuous sports	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) <u>Moderate activities</u> such as moving a table, pushing a vacuum, bowling or playing golf	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Lifting or carrying groceries	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Climbing <u>several</u> flights of stairs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Climbing <u>one</u> flight of stairs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Bending, kneeling or stooping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Walking <u>more than a mile</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) Walking <u>several hundred yards</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i) Walking <u>one hundred yards</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j) Bathing or dressing yourself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a) Cut down on the <u>amount of time</u> you spent on work or other activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) <u>Accomplished less</u> than you would like	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Were limited in the <u>kind</u> of work or other activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Had <u>difficulty</u> performing work or other activities (for example, it took extra effort)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a) Cut down on the <u>amount of time</u> you spent on work or other activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) <u>Accomplished less</u> than you would like	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Did work or other activities <u>less carefully than usual</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors or groups?

- Not at all
- Slightly
- Moderately
- Quite a bit
- Extremely

7. How much **bodily** pain have you had during the past 4 weeks?

- None
- Very mild
- Mild
- Moderate
- Severe
- Very severe

8. During the past four weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

- Not at all
- A little bit
- Moderately
- Quite a bit
- Extremely

9. These questions are about how you feel and how things have been with you during the past four weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a) did you feel full of life?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) have you been very nervous?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) have you felt so down in the dumps nothing could cheer you up?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) have you felt calm and peaceful?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) did you have a lot of energy?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) have you felt downhearted and depressed?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) did you feel worn out?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) have you been happy?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i) did you feel tired?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

- All of the time
- Most of the time
- Some of the time
- A little of the time
- None of the time

11. How **TRUE** or **FALSE** is each of the following statements for you?

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false
a) I seem to get sick a little easier than other people	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) I am as healthy as anybody I know	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I expect my health to get worse	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) My health is excellent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**THANK YOU FOR COMPLETING
THESE QUESTIONS!**

APPENDIX D

SF-36v2™ Health Survey

NORMS FOR THE GENERAL U.S. POPULATION*

Total Sample (N=6742)								
	PF	RP	BP	GH	VT	SF	RE	MH
Mean	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
25th Percentile	46.51	47.06	41.83	44.83	45.85	45.94	48.10	44.38
50th Percentile (median)	54.93	54.40	51.13	51.98	52.09	56.85	55.88	52.82
75th Percentile	57.03	56.85	55.36	57.70	58.33	56.85	55.88	58.46
Standard Deviation	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Range	14-58	17-57	19-63	16-64	20-71	13-57	09-56	7-65

Males (N=2710)								
	PF	RP	BP	GH	VT	SF	RE	MH
Mean	51.41	50.99	50.96	50.66	51.36	50.98	51.10	51.26
25th Percentile	50.72	49.51	46.06	45.78	45.85	45.94	48.10	47.19
50th Percentile (median)	54.93	56.85	51.13	52.93	52.09	56.85	55.88	52.82
75th Percentile	57.03	56.85	57.05	57.70	58.33	56.85	55.88	58.46
Standard Deviation	9.11	9.54	9.59	9.72	9.60	9.33	9.31	9.30
Range	14-58	17-57	19-63	16-64	20-71	13-57	09-56	07-65

Females (N=1412)								
	PF	RP	BP	GH	VT	SF	RE	MH
Mean	48.70	49.09	49.11	49.39	48.74	49.09	48.98	48.84
25th Percentile	44.41	44.61	41.41	43.40	42.72	45.94	44.22	44.38
50th Percentile (median)	52.82	54.40	51.13	50.55	48.97	56.85	55.88	50.00
75th Percentile	57.03	56.85	55.36	57.70	55.21	56.85	55.88	57.05
Standard Deviation	10.59	10.33	10.29	10.22	10.19	10.50	10.50	10.48
Range	14-58	17-57	19-63	16-64	20-71	13-57	09-56	07-65

* Adapted by permission from the "How to Score Version 2 of the SF-36 Health Survey (Standard & Acute Forms)" Table 8.1, p.63, by John E. Ware, Jr., Ph.D., Mark Kosinski, MA., James E. Dewey, PHD., published by the Medical Outcomes Trust and QualityMetric Incorporated, Copyright (c) 2000, 2002.

APPENDIX E

Sun Salutation Modified Version



1. Begin in Prayer Position



2. Inhale arms up into Raised Arm Pose



3. Exhale into Hands to Toe Pose (Modified)



4. Inhale into Equestrian Pose



5. Exhale into Mountain Pose



6. Inhale into Cow Pose



7. Exhale into Cat Pose



8. Continue Exhaling into Mountain Pose



9. Inhale into Equestrian Pose



10. Exhale into Hand to Toe Pose (Modified)



11. Inhale into Raised Arm Pose



12. Exhale into Prayer Pose

Sun Salutation Full Version



1. Begin in Prayer Position



2. Inhale arms up into Raised Arm Pose



3. Exhale into Hands to Toe Pose (Full Version)



4. Inhale into Equestrian Pose



5. Exhale into Mountain Pose



6. Hold Breath Out into Eight Point Pose



7. Inhale into Striking Cobra Pose



8. Exhale into Mountain Pose



9. Inhale into Equestrian Pose



10. Exhale into Hand to Toe Pose (Full Version)



11. Inhale into Raised Arm Pose



12. Exhale into Prayer Pose

APPENDIX F

ॐ ॐ ॐ ॐ ॐ ॐ Yoga Practice Journal ॐ ॐ ॐ ॐ ॐ ॐ

Date:
Morning Practice:

Evening Practice

Date:
Morning Practice:

Evening Practice

Date:
Morning Practice:

Evening Practice

Date:
Morning Practice:

Evening Practice

Date:
Morning Practice:

Evening Practice

Date:
Morning Practice:

Evening Practice