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Acute Hemodynamic Responses to Yoga Exercise

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by

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Thesis

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Abstract

Acute Hemodynamic Responses to Yoga Exercise

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The University of Texas at Austin, 2010

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The primary purpose of the present study was to determine the acute hemodynamic responses to twenty-three select yoga postures in advanced and novice yoga practitioners. Additionally, we sought to determine if trunk flexibility is related to arterial stiffness. Using a cross-sectional study design, 37 apparently healthy adults (26 females and 11 males; 22-71 years old) were divided into two groups according to level of yoga experience. Beat-to-beat measures of blood pressure, stroke volume, cardiac work-load, cardiac output, and total peripheral resistance were measured using a finger plethysmograph during the yoga routine. Baseline measures of trunk flexibility (sit-and-reach scores and inclinometer measurements) and arterial stiffness (carotid-femoral pulse wave velocity) were also compared. Yoga postures elicited significant increases in heart rate, blood pressure and cardiac output ($P < 0.05$) for both groups. There was no difference

in blood pressure responses between the two groups throughout the yoga testing session.

Lumbar flexion, as measured by an inclinometer, was significantly ($P < 0.01$) and

inversely associated with cfPWV ($r = -0.52$).

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Introduction

Yoga is an alternative form of exercise designed to improve flexibility, muscular strength, and overall health. It is qualitatively different from any other mode of physical activity in that it consists of a unique combination of isometric muscle contractions, stretches, relaxation techniques, and breathing exercises. It is rapidly gaining popularity in the United States with an estimated 6.1 percent of Americans engaging in yoga for health in 2007, an increase from the 5.1 percent estimated by a 2002 survey and 3.8 percent in 1998¹⁻². Researchers have also shown an increased interest in yoga. The metabolic cost of yoga routines have been classified as mild to moderate intensity exercise, suggesting that it would not likely lead to observable improvements in cardiovascular health or body composition⁸⁻¹¹. Yet, previous investigations have demonstrated the potential benefits of yoga practice and yoga interventions on various aspects of mental and physical health such as stress, anxiety, blood pressure, glucose tolerance and the main components of physical fitness including body composition, muscular strength, muscular endurance and flexibility⁵⁻⁷.

Yoga postures (asanas) involve whole-body or systemic isometric contractions. Isometric muscle contractions are one of few modalities that are known to elicit marked increases in mean arterial blood pressure. In addition, some yoga postures require whole body inversions, which result in redistribution of blood flow and a perturbation in blood pressure regulatory mechanisms³⁰. Currently, it is not known how much blood pressure and hemodynamic measures increase with various postures and how those changes may differ depending on the level of yoga experience.

Yoga practice is known to improve trunk flexibility¹²⁻¹³, and yoga practitioners have reduced arterial stiffness compared with sedentary controls¹⁸. Given recent findings that trunk flexibility is significantly related to arterial stiffness in older individuals¹⁴⁻¹⁵. It is of interest to determine whether greater trunk flexibility of yoga practitioners are associated with reduced levels of arterial stiffness.

The primary purpose of the present study was to determine the acute effects of twenty-three select yoga postures on beat-to-beat measures of blood pressure in experienced and novice yoga practitioners. In an attempt to comprehensively capture hemodynamic responses to yoga, heart rate, stroke volume, cardiac work-load (myocardial oxygen demand), cardiac output, and total peripheral resistance were measured during each posture for both groups. Additionally, we sought to determine if trunk flexibility is related to arterial stiffness. Our hypotheses are that (1) blood pressure will increase significantly during each of the twenty-three yoga postures; (2) the degree to which blood pressure increases will vary between posture classifications according to the following trend: Standing Postures > Inversion Postures > Floor postures; (3) novice practitioners will experience greater increases in blood pressure elicited by the selected postures; (4) rate pressure product, an index of myocardial oxygen demand, will be greater during yoga practice for novice practitioners; (5) trunk flexibility will be inversely associated with arterial stiffness.

Definition of Terms

Arterial compliance:

It is the ability of an artery to expand and recoil with changes in arterial pressure.

Arterial Stiffness:

Stiffness of the arteries associated with age and atherosclerosis. Increased arterial stiffness is associated with an increased risk of cardiovascular events.

Asanas:

Postures/poses that are the main physical component of yoga

Atherosclerosis:

Atherosclerosis is a disease affecting arterial blood vessels, often started by endothelial dysfunction and associated with deposition of oxidized lipoproteins in arterial walls along with an inflammatory response

Cardiac output (Q):

Volume of blood being pumped from the ventricle of heart per minute. In addition, cardiac output is the product of stroke volume and heart rate.

$$\text{Cardiac output} = \text{Stroke volume} \times \text{Heart rate}$$

Hatah yoga:

A general name for a more modern form of yoga; also known as physical yoga.

Mean Arterial Pressure (MAP):

The average arterial pressure during a single cardiac cycle.

Meditation:

A practice in which the mind is calm and focused

Pranayamas:

General name for controlled breathing exercises that are practiced in yoga

Pulse Wave Velocity (PWV):

A well-established technique for obtaining a measure of arterial stiffness between two locations in the arterial tree. The velocity of the pulse wave along an artery is dependent on the stiffness of that artery.

Rate of Perceived Exertion (RPE):

A scale (6 to 20) quantifying feelings of fatigue, which is closely related to heart rate.

Rate Pressure Product (RPP):

Heart rate multiplied by the systolic blood pressure. It is a clinical indicator of myocardial oxygen demand or the work load of the heart (also known as Double Product)

$$\text{Rate pressure product} = \text{Systolic blood pressure} \times \text{Heart rate}$$

Total peripheral resistance (TPR):

Sum of the opposing resistance to blood flow produced from peripheral microvasculatures (e.g. arterioles). TPR is determined by diameter of arteries and viscosity of blood (also known as *systemic vascular resistance*). It is calculated from the equation below:

$$\text{Total peripheral resistance} = \text{Mean arterial pressure} / \text{Cardiac output}$$

Literature Review

Yoga is an alternative form of exercise designed to improve flexibility, muscular strength, and overall health. It is qualitatively different from any other mode of physical activity in that it consists of a unique combination of isometric muscle contractions, stretches, relaxation techniques, and breathing exercises²¹. These individual components of yoga have each been shown to provide potential benefits to cardiovascular health measures by lowering resting blood pressure and heart rate, improving baroreceptor sensitivity, and increasing heart rate variability over time^{3-4, 22-23}. Additionally, several studies of long term yoga practice and yoga interventions have shown that the combination of these components through yoga exercise may also help to reduce reported measures of anxiety and stress, improve cardiovascular endurance and cardio-respiratory efficiency, reduce body weight, improve glucose tolerance and blood lipid profiles, decrease arterial stiffness, decrease sympathetic activity, improve endothelial-dependent vasodilatation in patients with known coronary artery disease, retard coronary atherosclerosis and improve other indices of cardiovascular disease risk^{5-8, 20, 24-28}. Interestingly, cross-sectional studies designed to evaluate the acute effects (metabolic cost, blood pressure and heart rate response, caloric expenditure, rating of perceived exertion, oxygen consumption, etc.) of yoga exercise have classified it as mild to moderate exercise not capable of eliciting significant improvements in aerobic capacity or cardiovascular parameters⁹⁻¹¹. However, it is important to note that these cross-sectional studies focused only on the physiological responses of experienced yoga practitioners and, therefore, the results may not be generalized to untrained, sedentary populations and those at higher risk for cardiovascular disease. No previous studies have

been conducted to evaluate the possible differences in the degree of acute cardiovascular response to yoga exercise in populations who have never or rarely practiced yoga. It is possible that experienced yoga practitioners exhibit training specific physiological adaptations to yoga exercise and that cardiovascular demand is greater for novice practitioners. If so, this difference may help explain the health benefits evident in intervention studies.

Central arterial stiffness increases with age and is an independent risk factor for cardiovascular disease. Joint flexibility also declines with advancing age. The precise mechanism behind each of these changes is multi-faceted and has not yet been clearly defined. However, both result in a loss of connective tissue elasticity due, at least in part, to structural changes in the extra-cellular matrix, specifically, the degeneration of elastin fibers and the proliferation of collagen fibers¹⁶⁻¹⁹. Given the prevalence of cardiovascular disease and the contribution of central arterial stiffness, researchers are searching for ways to prevent or attenuate this decrease in the elastic properties of central arteries. A recent study has shown that arterial stiffness is inversely associated with trunk flexibility in older populations¹⁴. This suggests the possibility of a link between the preservation of joint flexibility and reduced arterial stiffness. This is of particular interest to yoga practitioners as yoga exercise has been shown by several intervention studies to improve flexibility¹²⁻¹³. Additionally, a 2007 resistance training intervention study found that a control group of middle-age individuals who performed stretching exercises for 13 weeks significantly improved carotid arterial compliance¹⁵. In a more recent cross-sectional study, researchers found that middle-aged individuals who practiced yoga at least twice a week had significantly lower arterial stiffness measures than aged matched sedentary individuals²⁰. Unfortunately, trunk flexibility was not evaluated in either study.

As such, it is not known if reductions in arterial stiffness are associated with increases in flexibility or the potential relationship these measures share with years of yoga experience.

Methods

Subjects

The subjects were 37 apparently healthy, non-obese, sedentary or recreationally active individuals between the ages of 18 and 75 years. Health status was determined Research Health questionnaire prior to admittance into the study. Two groups of subjects were studied; a) advanced yoga practitioners; b) novice yoga practitioners. Advanced yoga practitioners must have practiced yoga an average of 3 or more hours per week for a minimum of 12 consecutive months. Novice yoga practitioners must have never or rarely practiced yoga (no more than an average of 1 hour per month) in the last 12 months. Groups were matched for age, gender and body composition. Participants were recruited from The University of Texas at Austin, local yoga studios, and the surrounding community via flyers delivered by e-mail and posted at various studios and locations around Austin. Exclusion criteria included: i) smoking within past six months; ii) uncontrolled hypertension-defined as blood pressure $>140/90$ mmHg while on antihypertensive medication; iii) personal history of diabetes, heart disease, or other known cardiovascular problems; iv) obesity, defined as BMI > 30 kg/m²; v) endurance training. Informed consent was obtained by trained research personnel using only IRB-approved procedures.

Procedures

Session One:

Subjects arrived at the laboratory a minimum of four-hours fasted and having abstained from alcohol and caffeine for the previous twelve hours and having abstained

from strenuous physical activity for the previous twenty-four hours. A research health questionnaire, training status questionnaire and yoga experience questionnaire were completed by each participant. The training status questionnaire, which was designed to assess the intensity, duration and type of weekly physical activity, along with the yoga experience questionnaires were used to calculate Exercise Score.

Blood pressure, heart rate and arterial stiffness was assessed using the following protocol: Participants rested in the supine position for at least 15 minutes in a quiet, dimly lit, temperature-controlled room (23-25 C°). Three consecutive measures of heart rate, blood pressure, and carotid and femoral arterial pulse waves were then obtained by investigators using arterial applanation tonometry Colin VP-2000 machine (Colin Medical, San Antonio, TX). The carotid tonometry sensor was held in place by a neck brace, while the femoral sensor was held in place using a velcro strap. These measures, along with the measured distance between sensors were then used to calculate carotid-femoral pulse wave velocity (cfPWV).

Height, body mass, and skin fold measurements (Lange Skinfold Caliper; Beta Technology, Santa Cruz, California) were then taken for the calculation of body mass index (BMI) and body fat percentage. Body fat percentage was calculated using the Jackson/Pollock three site method for both male and female subjects³¹. Trunk or lumbar flexibility was assessed using a Traditional sit-and-reach test and an inclinometer (ISOMED Uni-Level Inclinometer, ISOMED, INC., Portland, OR) following a five minute warm-up on treadmill.

Finally, participants underwent a familiarization session during which the testing procedures for Session Two were explained and participants practiced performing the yoga postures while wearing the Portapres wristband and finger plethysmograph

(Portapres Finger Plethysmograph; Finapres Medical Systems (FMS) BV, Amsterdam, The Netherlands). Accommodations were made with regard to birth control and menstrual cycles for female subjects so that all testing took place during the follicular phase of the menstrual cycle or during placebo portion of birth control cycles.

Session Two:

Finger arterial pressure was measured continuously throughout the session using beat-to-beat finger plethysmography (Portapres Finger Plethysmograph; Finapres Medical Systems (FMS) BV, Amsterdam, The Netherlands). For this procedure, participants wore a wrist band along with a finger plethysmograph on the middle or index finger to allow for appropriate finger cuff fit. All Portapres data was recorded and interpreted using Beatscope software (Beatscope 1.1a software; Finapres Medical System (FMS) BV, Amsterdam, The Netherlands). Once stable, pre-exercise standing baseline values were established for heart rate and blood pressure, each subject followed an instructional yoga video routine consisting of a series of twenty-three hatha-based yoga postures (categorized as: 9 standing postures; 11 floor postures; 3 inversion postures) designed to mimic a typical hatha yoga session (Table 2). Postures were held on average for 22 ± 2 seconds. Participants were allowed to attempt each yoga posture as many times as necessary for successful completion of the entire yoga routine. Participants were also encouraged to avoid performing any posture with which they did not feel comfortable. The number of subjects who completed each posture is listed in Table 2. The Borg scale was used to assess ratings of perceived exertion (RPE) between standing, floor and inversion posture series.

All 37 subjects completed both sessions. Because one subject in the novice group's data file was corrupt and could not be analyzed in the Beatscope software, the data of 36 subjects were analyzed and presented. Hemodynamic responses to each yoga posture must have reached steady-state for at least ten consecutive measurements in every subject in order to be considered for analysis. Steady-state was defined by consecutive measurements in which heart rate did not vary by more than 10 beats per minute and systolic blood pressure did not vary by more than 20 mmHg. In the event steady-state was not reached or a posture was not attempted or successfully performed, those data were excluded from analysis.

Statistical Analyses

An independent t-test was then used to compare baseline values between the novice and advanced groups. Pearson Product-moment correlation were used to assess associations between trunk flexibility, arterial stiffness (measured by pulse wave velocity), age, systolic blood pressure, and years of yoga experience. Two-way repeated measure ANOVA (postures x groups) was used to assess hemodynamic responses to yoga postures in both groups. Significance was set *a priori* at $p < 0.05$. All descriptive statistical data was reported as mean \pm SD for subject characteristics, and mean \pm SE was used for hemodynamic responses depicted in figures. Fisher's LSD *Post hoc* analyses were used for all significant F-values between groups to identify significant differences among mean values for the various postures.

Results

Participants were age matched and apparently healthy as demonstrated by mean blood pressure, body fat percentage and BMI values, which were well within clinically normal ranges (Table 1).

Yoga Experience and Hemodynamic Responses to Yoga Exercise

Blood pressure responses are displayed in Figure 1. Overall, there was no difference in blood pressure responses between the two groups throughout the yoga testing session. Heart rate responses were significantly greater in the advanced group for 10 of the 23 postures, while stroke volume was significantly greater for 4 postures in the novice group. There was no difference in cardiac output, total peripheral resistance, and rate pressure product (double product) between groups at any time during the yoga routine (Figure 2). Rating of perceived exertion (RPE) was not different between advanced vs. novice groups (standing = 11.5 ± 1.0 vs. 12.5 ± 2.2 ; floor = 10 ± 1.3 vs. 10.5 ± 2.1 , inversion = 11 ± 2.1 vs. 12.5 ± 1.8) for any yoga posture.

Hemodynamic Responses to Yoga Postures

Yoga postures elicited significant increases in heart rate, blood pressure and cardiac output as presented in Figures 3 and 4. Categorically, the series of nine standing postures evoked significantly greater increases in systolic blood pressure, heart rate, cardiac output and rate pressure product than the floor or inversion postures (Table 3).

Flexibility and Arterial Stiffness

Table 4 displays correlations between measures of age, blood pressure, carotid-femoral pulse wave velocity, trunk flexibility (lumbar flexion and Sit-and-Reach test), and years of yoga experience for all participants (N=37). Years of yoga experience was significantly ($P<0.001$) and positively associated with Sit-and-Reach test scores ($r=0.56$) but not with lumbar flexion as assessed by an inclinometer. Lumbar flexion was significantly ($P<0.01$) and inversely associated with cfPWV ($r=-0.52$); however, partial correlation analysis controlling for the influence of age and systolic blood pressure removed significance from this association.

Discussion

To the best of our knowledge, this is the first study to evaluate acute hemodynamic responses to yoga postures in both advanced and novice practitioners. In order to comprehensively address this, a total of twenty-three postures were examined using beat-to-beat measures of blood pressure. The primary findings of the current study were that yoga postures evoked significant increases in mean blood pressure and that yoga experience was not associated with different hemodynamic responses.

Previous cross-sectional studies involving only experienced yoga practitioners have helped researchers to identify yoga as a mild to moderate intensity exercise that is not likely capable of eliciting the prolonged cardiopulmonary stimuli required to produce significant improvements in cardiovascular health or fitness⁸⁻¹⁰. Our results suggest that the myocardial oxygen demand of yoga exercise is not amplified in novice practitioners. Yet, through multiple studies of long term yoga exercise and yoga based interventions, yoga is capable of providing a multitude of cardiovascular health benefits^{5-8, 20, 24-28}. It is

possible that these benefits may be mediated by associated lifestyle changes, reductions in stress and anxiety or a combination of factors not evaluated in the present study.

It has been suggested that “postural malalignment” is associated with elevated blood pressure responses during yoga exercises¹⁰. If this association indeed exists, it is plausible to predict that experienced yoga practitioners would likely experience a reduced blood pressure response to the performance of yoga postures. Although we did not evaluate postural alignment directly, the results of our study cannot be interpreted to support this notion as there was no difference in blood pressure responses between advanced and novice groups. Accordingly, healthy novice practitioners do not appear to be at a higher risk of experiencing vascular injury while performing yoga postures. In the present study, standing yoga postures did evoke a significantly higher blood pressure response than floor or inversion postures. As such, these postures may be contraindicated for individuals who have recently experienced a primary cardiovascular event (stroke, myocardial infarction, coronary revascularization, etc.) or those individuals with a high risk score due to uncontrolled hypertension, genetic disorders, a history of transient ischemic attacks, etc. This finding could be of clinical importance given ever increasing popularity of yoga exercise as an alternative method of prevention and treatment for at risk populations as well as those with known cardiovascular disease^{6-7, 24-26}.

In the present study, sit-and-reach test scores of trunk flexibility were significantly greater in the advanced practitioners ($P < 0.001$). Years of yoga experience were significantly and positively associated with trunk flexibility according to sit-and-reach test measures ($P < 0.001$, $r = 0.52$). This positive association is in accordance with previous studies demonstrating improvements in flexibility following yoga

interventions.¹²⁻¹³ In a recent study, Yamamoto, et al, found that poor trunk flexibility, measured by a sit-and-reach test, was associated with arterial stiffening in older populations.¹⁴ In the present study sit-and-reach test scores showed no association with measures of arterial stiffness whether groups were combined, analyzed independently, or stratified by age. Interestingly, there was a significant correlation between lumbar flexion, as assessed by an inclinometer, and arterial stiffness ($P < 0.01$, $r = -0.52$). The validity of sit-and-reach tests for the assessment of flexibility has been controversial. It is likely that the sit-and-reach test and lumbar flexion may be capturing different entities.

In conclusion, we observed significant increases in mean blood pressure during all yoga postures as well as no group difference in hemodynamic responses to yoga exercise between advanced and novice practitioners. If exercise specific physiological adaptations to yoga exercise exist, they were not reflected in the hemodynamic responses in our population of healthy practitioners. Yoga experience, quantified in years, was independently associated with higher flexibility scores and flexibility was significantly associated with arterial stiffness.

Table 1. Selected Subject Characteristics

	Advanced Yoga Group	Novice Yoga Group
<i>N</i>	18	19
Sex (F/M)	13/5	13/6
Age (yrs)	44±13	44±16
BMI (kg/m ²)	23±4	23±4
Body Fat (%)	22±7	22±7
Heart Rate (bpm)	60±8	54±11*
Systolic BP (mmHg)	115±17	115±11
Diastolic BP (mmHg)	68±11	69±7
cfPWV (cm/sec)	961±238	940±180
Lumbar Flexion (degrees)	42±14	35±9
Sit & Reach (cm)	44±7	32±8†
Exercise Score	37± 27	39±19
Yoga Experience (yrs)	10±6	0±0

* P < 0.05; † P < 0.001

Values are mean±SD. BMI = body mass index; BP = blood pressure; cfPWV = carotid-femoral pulse wave velocity

Table 2. Posture classification by category

Category	Posture Name	Completed Posture (n) Advanced/Novice
Standing	Awkward 1 (AK1)	18/18
	Awkward 2 (AK2)	18/18
	Awkward 3 (AK3)	18/18
	Standing Bow (SB)*	18/15
	Balancing Stick (BS)*	18/18
	Warrior (W)*	17/18
	Triangle (T)*	17/18
	Separate Leg Stretch (SLS)	18/18
	Tree Pose (TP)*	16/17
Floor	Savasana (S1)	18/18
	Cobra (C)	13/11
	Full Locust (FL)	18/18
	Half Tortoise (HT)	18/18
	Camel Pose (CP)	15/17
	Head to Knee (HK)*	18/18
	Stretch (S)	17/18
	Pigeon (P)*	18/17
	Spine Twist (ST)*	18/18
	Bridge	16/18
	Easy Pose (EP)	18/18
Inversion	Shoulder Stand (SS)	17/16
	Plow	15/18
	Head Stand (HS)	11/8

*Some postures were performed bilaterally and reported values are the average of both sides

Table 3. Hemodynamic responses to different posture categories (N=36)

	PRE-EXERCISE BASELINE (STANDING)	Δ WITH INVERSION POSTURES	Δ WITH FLOOR POSTURES	Δ WITH STANDING POSTURES
SBP (mmHg)	124	11	16	41*‡
DBP (mmHg)	57	18*	17*	23*
MAP (mmHg)	76	19*	19*	31*
HR (bpm)	75	0	8*†	20*‡
CO (L/min)	5.70	0.47*†	0.09	1.96*‡
RPP (au)	95	21*	25*	66*‡

* P<0.05 from pre-exercise baseline

† P<0.05 from floor or inversion postures

‡ P<0.05 from floor and inversion postures

SBP=systolic blood pressure; DBP=diastolic blood pressure; MAP=mean arterial pressure; HR=heart rate; CO=cardiac output; RPP=rate pressure product

Table 4. Pearson product-moment correlation coefficients (N=37)

	Age	cfPWV	Systolic BP	Sit & Reach	Lumbar Flexion	Yoga Experience
Age		0.58 (P<0.001)	NS	NS	-0.39 (P<0.05)	NS
cfPWV			.66 (P<0.001)	NS	-0.52 (P<0.01)	NS
Systolic BP				NS	-0.38 (P<0.05)	NS
Sit & Reach					NS	0.56 (P<0.001)
Lumbar Flexion						NS
Yoga Experience						

BP= blood pressure; cfPWV=carotid-femoral pulse wave velocity

Figure 1. Blood Pressure Responses to Yoga Postures

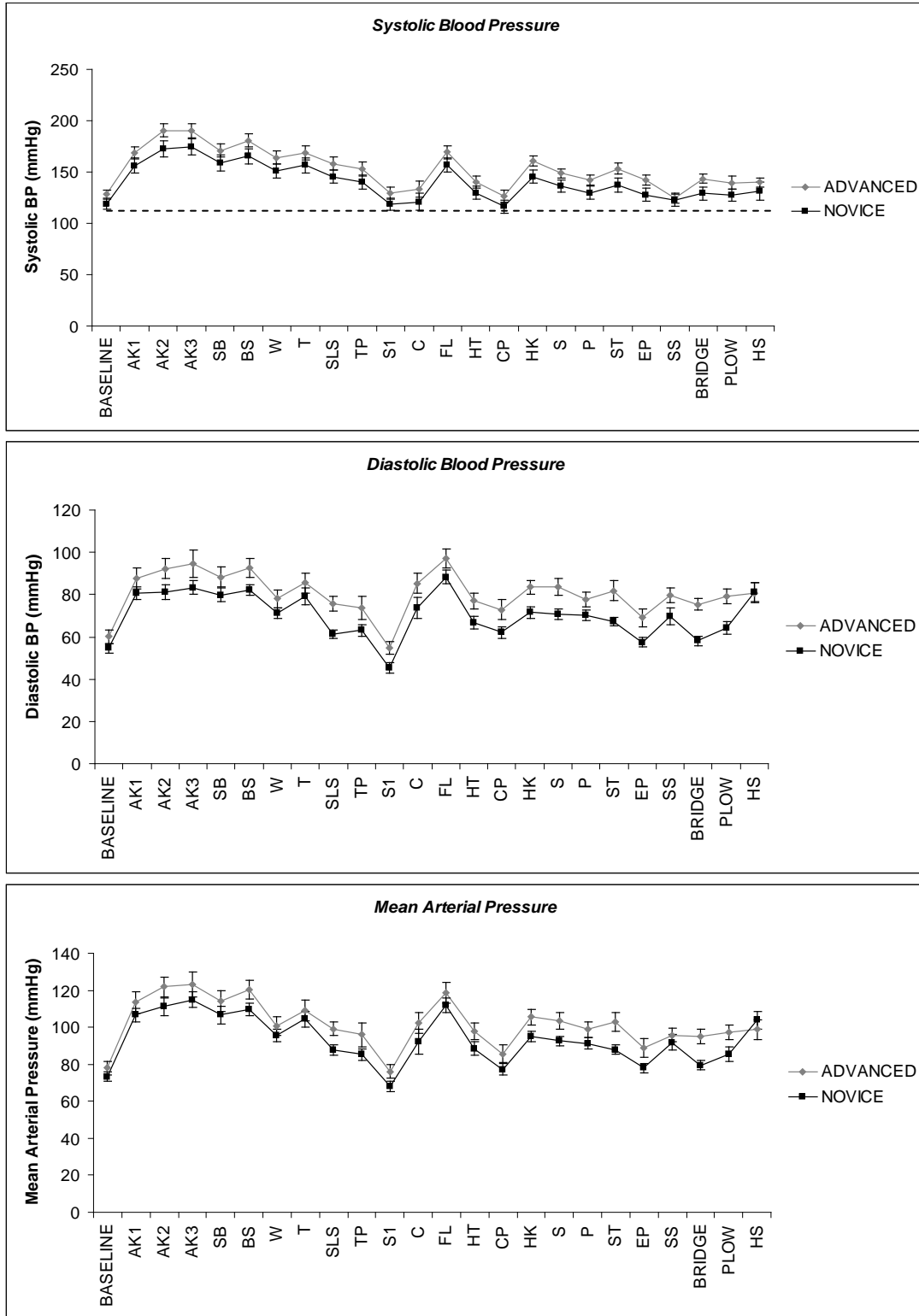
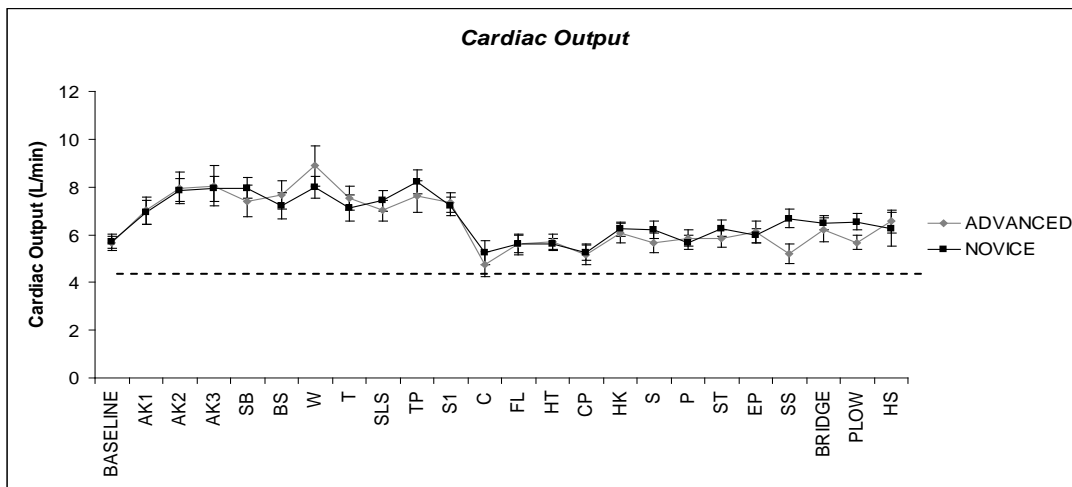
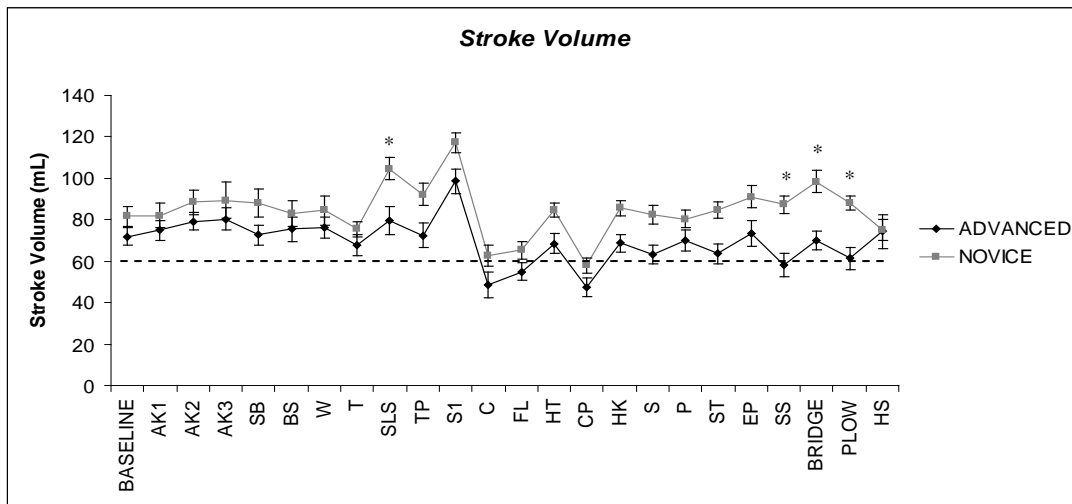
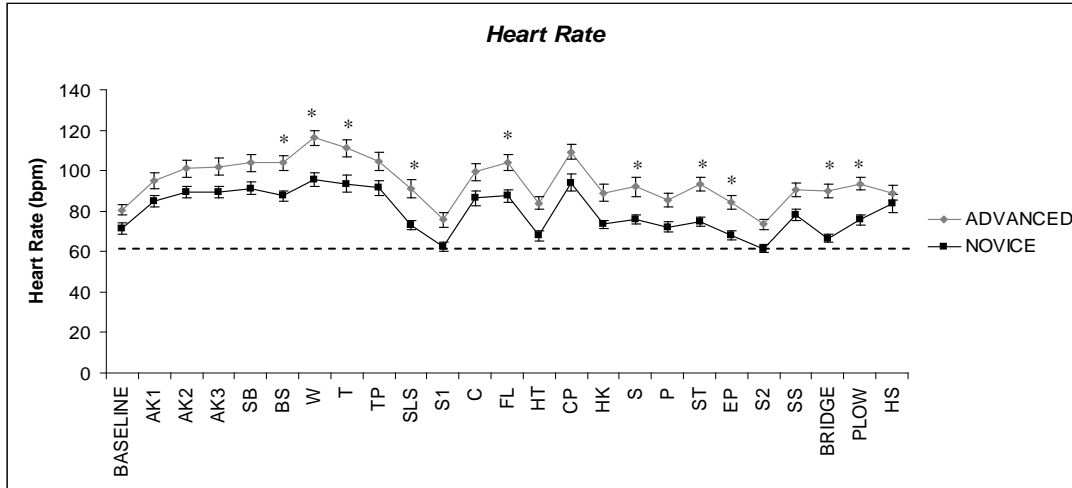
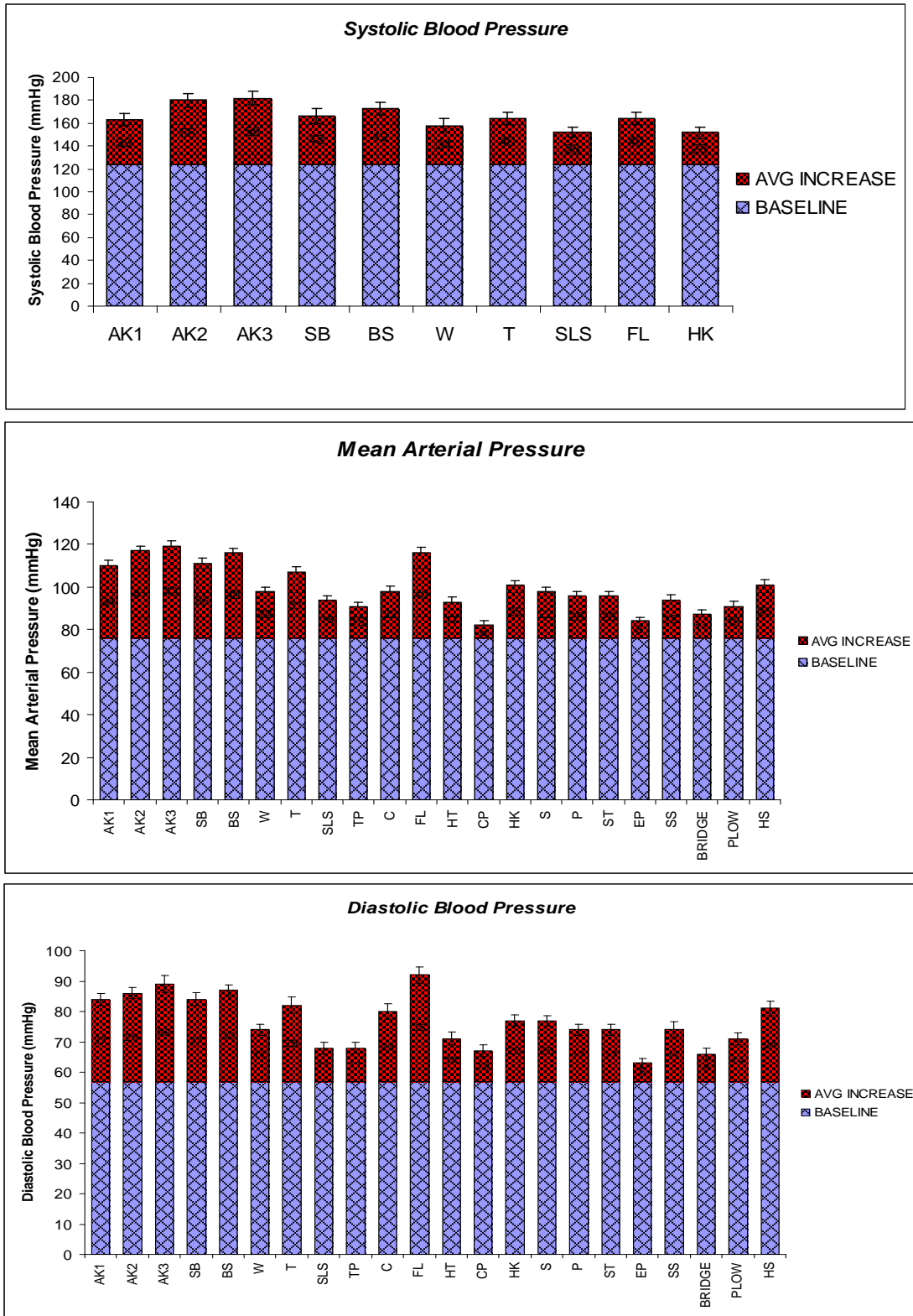


Figure 2. Heart rate, stroke volume and cardiac output responses to yoga postures



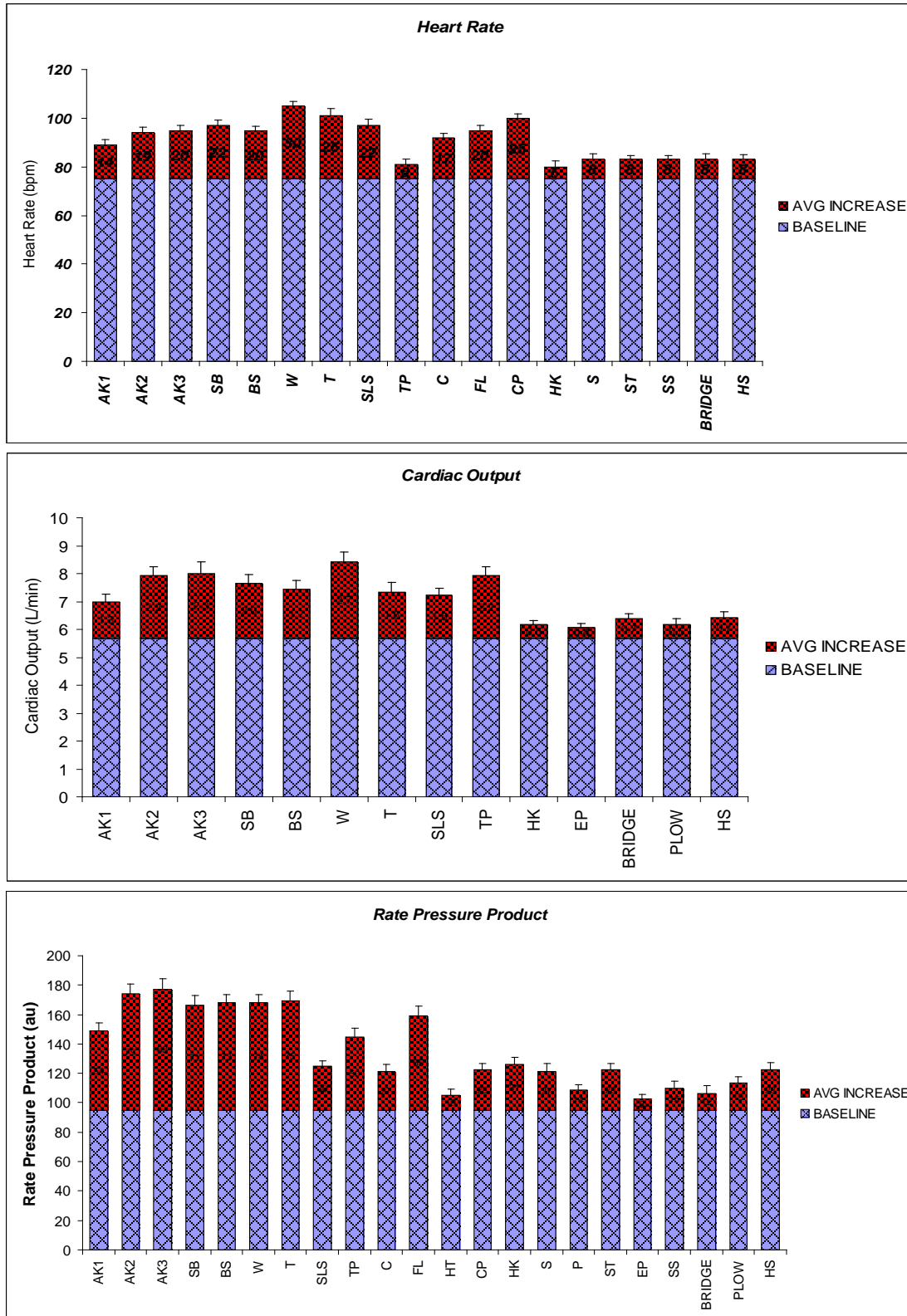
*P<0.05

Figure 3. Combined group blood pressure responses to yoga postures



All data points were significantly ($P < 0.05$) different from baseline.

Figure 4. Combined group cardiac responses to yoga postures



All data points were significantly ($P < 0.05$) different from baseline.

Appendices

Appendix A

Research Health Questionnaire Cardiovascular Aging Research Laboratory

Personal Information

Today's Date _____ Subject ID _____

Date of Birth _____ Age _____ Sex Male
 Female: Date of Last Menstrual Period: _____

Please circle the highest grade in school you have completed:

Elementary school	1	2	3	4	5	6	7	8
High school	9	10	11	12				
College/Post Grad	13	14	15	16	17	18	19	20+

What is your marital status? Never Married Married Widowed Divorced; Separated

Ethnic Background: Hispanic or Latino Not Hispanic or Latino

Race:

White American Indian/Alaskan Native Pacific Islander
 Black or African American Asian Other: _____

Symptoms or Signs Suggestive of Disease

Check appropriate box:

- | Yes | No | |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Have you experienced unusual pain or discomfort in your check, neck, jaw, arms or other areas that may be due to heart problems? |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Have you experienced unusual fatigue or shortness of breath at rest, during usual activities, or during mild-to-moderate exercise (e.g., climbing stairs, carrying groceries, brisk walking, cycling)? |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. When you stand up, or sometimes during the night while you are sleeping, do you have difficulty breathing? |
| <input type="checkbox"/> | <input type="checkbox"/> | 4. Do you lose your balance because of dizziness or do you ever lose consciousness? |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Do you suffer from swelling of the ankles (ankle edema)? |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. Have you experienced an unusual and rapid throbbing or fluttering of the heart? |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Have you experienced severe pain in your leg muscles during walking? |
| <input type="checkbox"/> | <input type="checkbox"/> | 8. Has a doctor told you that you have a heart murmur? |

Chronic Disease Risk Factors

Check appropriate box:

- | Yes | No | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 9a. Are you a male over age 45 years or a female over age 55 years? |
| <input type="checkbox"/> | <input type="checkbox"/> | b. Are you a female who has experienced premature menopause? |
| <input type="checkbox"/> | <input type="checkbox"/> | c. If you answered "yes" to 9b, are you on estrogen replacement therapy? |
| <input type="checkbox"/> | <input type="checkbox"/> | 10. Has your father or brother had a heart attack or died suddenly of heart disease before the age of 55; has your mother or sister experienced these heart problems before the age of 65? |
| <input type="checkbox"/> | <input type="checkbox"/> | 11. Are you a current cigarette smoker?
If quit smoking, when? Date: _____ |

- | Yes | No | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 12. Has a doctor told you that you have high blood pressure (more than 140/90 mm Hg) or a heart condition? |
| <input type="checkbox"/> | <input type="checkbox"/> | 13. Is your total serum cholesterol greater than 200 mg/dl, or has a doctor told you that your cholesterol is at a high risk-level? |
| <input type="checkbox"/> | <input type="checkbox"/> | 14. Do you have diabetes mellitus? |
| <input type="checkbox"/> | <input type="checkbox"/> | 15. Are you physically inactive and sedentary (little physical activity on the job or during leisure time)? |
| <input type="checkbox"/> | <input type="checkbox"/> | 16. Do you have a bone or joint problem that could be made worse by a change in your physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 17. During the past year, would you say that you have experienced enough stress, strain, and pressure to have a significant effect on your health? |
| <input type="checkbox"/> | <input type="checkbox"/> | 18. Do you eat foods nearly every day that are high in fat and cholesterol such as fatty meats, cheese, fried foods, butter, whole milk, or eggs? |
| <input type="checkbox"/> | <input type="checkbox"/> | 19. Do you weigh 30 or more pounds than you should? |
| <input type="checkbox"/> | <input type="checkbox"/> | 20. Do you know of any other reason you should not do physical activity? |

Medical History

21. Please check which of the following conditions you have had or now have. Also check medical conditions in your family (father, mother, brother(s), or sister(s)). Check as many as apply.

Self	Family	Medical Condition	Self	Family	Medical Condition
<input type="checkbox"/>	<input type="checkbox"/>	Coronary heart disease, heart attack; by-pass surgery	<input type="checkbox"/>	<input type="checkbox"/>	Major injury/fracture to foot, leg, knee
<input type="checkbox"/>	<input type="checkbox"/>	Arrhythmias	<input type="checkbox"/>	<input type="checkbox"/>	Major injury to back or neck
<input type="checkbox"/>	<input type="checkbox"/>	Angina	<input type="checkbox"/>	<input type="checkbox"/>	Major injury/fracture to hip or shoulder
<input type="checkbox"/>	<input type="checkbox"/>	Marfan's syndrome			
<input type="checkbox"/>	<input type="checkbox"/>	High blood pressure	<input type="checkbox"/>	<input type="checkbox"/>	Recent leg trauma/injury
<input type="checkbox"/>	<input type="checkbox"/>	Peripheral vascular disease	<input type="checkbox"/>	<input type="checkbox"/>	Rheumatoid arthritis
<input type="checkbox"/>	<input type="checkbox"/>	Phlebitis or emboli	<input type="checkbox"/>	<input type="checkbox"/>	Osteoarthritis
<input type="checkbox"/>	<input type="checkbox"/>	Other heart problems	<input type="checkbox"/>	<input type="checkbox"/>	Osteoporosis
<input type="checkbox"/>	<input type="checkbox"/>	Stroke	<input type="checkbox"/>	<input type="checkbox"/>	Fibromyalgia
<input type="checkbox"/>	<input type="checkbox"/>	Asthma	<input type="checkbox"/>	<input type="checkbox"/>	Chronic fatigue syndrome
<input type="checkbox"/>	<input type="checkbox"/>	Bronchitis	<input type="checkbox"/>	<input type="checkbox"/>	Systemic lupus erythematosus
<input type="checkbox"/>	<input type="checkbox"/>	C.O.P.D. (emphysema)	<input type="checkbox"/>	<input type="checkbox"/>	Anemia (low iron)
<input type="checkbox"/>	<input type="checkbox"/>	Pulmonary embolism (blood clots in lungs)	<input type="checkbox"/>	<input type="checkbox"/>	Thyroid problems
<input type="checkbox"/>	<input type="checkbox"/>	Deep vein thrombosis (blood clots in legs)	<input type="checkbox"/>	<input type="checkbox"/>	Gout
<input type="checkbox"/>	<input type="checkbox"/>	Antithrombin III deficiency	<input type="checkbox"/>	<input type="checkbox"/>	Kidney disease
<input type="checkbox"/>	<input type="checkbox"/>	Inherited hypercoaguability	<input type="checkbox"/>	<input type="checkbox"/>	Nephrotic syndrome
<input type="checkbox"/>	<input type="checkbox"/>	Acquired hypercoaguability	<input type="checkbox"/>	<input type="checkbox"/>	Gallstones/gallbladder disease
<input type="checkbox"/>	<input type="checkbox"/>	Factor V leiden mutations	<input type="checkbox"/>	<input type="checkbox"/>	Liver disease (cirrhosis)
<input type="checkbox"/>	<input type="checkbox"/>	Protein C deficiency	<input type="checkbox"/>	<input type="checkbox"/>	Hepatitis
<input type="checkbox"/>	<input type="checkbox"/>	Protein S deficiency	<input type="checkbox"/>	<input type="checkbox"/>	Diabetes mellitus
<input type="checkbox"/>	<input type="checkbox"/>	Stomach/duodenal ulcer	<input type="checkbox"/>	<input type="checkbox"/>	Raynaud's disease
<input type="checkbox"/>	<input type="checkbox"/>	Rectal growth or bleeding	<input type="checkbox"/>	<input type="checkbox"/>	Crohn's disease
			<input type="checkbox"/>	<input type="checkbox"/>	Hysterectomy
			<input type="checkbox"/>	<input type="checkbox"/>	Problems with menstruation

Self	Family	Medical Condition	Self	Family	Medical Condition
<input type="checkbox"/>	<input type="checkbox"/>	Irritable bowel syndrome	<input type="checkbox"/>	<input type="checkbox"/>	Post-menopausal
<input type="checkbox"/>	<input type="checkbox"/>	Lung cancer			Date:
<input type="checkbox"/>	<input type="checkbox"/>	Breast cancer	<input type="checkbox"/>	<input type="checkbox"/>	Allergies
<input type="checkbox"/>	<input type="checkbox"/>	Prostate cancer	<input type="checkbox"/>	<input type="checkbox"/>	Depression
<input type="checkbox"/>	<input type="checkbox"/>	Skin cancer	<input type="checkbox"/>	<input type="checkbox"/>	Anxiety, phobias
<input type="checkbox"/>	<input type="checkbox"/>	Colorectal cancer	<input type="checkbox"/>	<input type="checkbox"/>	Eating disorders
<input type="checkbox"/>	<input type="checkbox"/>	Other cancer	<input type="checkbox"/>	<input type="checkbox"/>	Substance abuse problems (alcohol, other drugs, etc.)
		Specify:			
<input type="checkbox"/>	<input type="checkbox"/>	Hearing loss	<input type="checkbox"/>	<input type="checkbox"/>	Sleeping problems
<input type="checkbox"/>	<input type="checkbox"/>	Cataracts	<input type="checkbox"/>	<input type="checkbox"/>	Other
<input type="checkbox"/>	<input type="checkbox"/>	Glaucoma			Specify:

Please specify and include information on any recent illnesses, hospitalizations, surgical procedures, or other health problems.

22a. Are you currently pregnant, think you may be pregnant, or are currently trying to get pregnant?

Yes No Not sure Not applicable (male or post-menopausal)

b. If you answered "yes" or "not sure" to 22a, do you need a pregnancy test? Yes No

23. In the past two weeks, have you had a barium test, a nuclear medicine scan, or x-rays with a dye injection?

Yes No

24. Please check any of the following medications you take regularly and give the name and dose of the medication.

Medication	Name of Medication
<input type="checkbox"/> Heart medicine	_____
<input type="checkbox"/> Blood pressure medicine	_____
<input type="checkbox"/> Blood cholesterol medicine	_____
<input type="checkbox"/> Thromboembolic disease medicine	_____
<input type="checkbox"/> Hypercoaguability medicine	_____
<input type="checkbox"/> Steroids	_____
<input type="checkbox"/> Hormones/HRT	_____
<input type="checkbox"/> Birth control medicine	_____
<input type="checkbox"/> Medicine for breathing/lungs	_____
<input type="checkbox"/> Insulin	_____
<input type="checkbox"/> Other medicine for diabetes	_____
<input type="checkbox"/> Arthritis medicine	_____
<input type="checkbox"/> Medicine for depression	_____
<input type="checkbox"/> Medicine for anxiety	_____
<input type="checkbox"/> Thyroid medicine	_____
<input type="checkbox"/> Medicine for ulcers	_____
<input type="checkbox"/> Painkiller medicine	_____
<input type="checkbox"/> Allergy medicine	_____
<input type="checkbox"/> Dietary supplements (herbs, vitamins, etc)	_____
<input type="checkbox"/> Other (please specify)	_____

25. Do you have any known drug allergies? _____

Body Weight

26. What is the most you have ever weighed? _____

27. Are you now trying to:

- Lose weight Gain weight Stay about the same Not trying to do anything

Stress

28. During the past month, how would you rate your overall level of stress?

- Very high High Moderate Low

29. In the past year, how much effect has stress had on your health?

- A lot Some Hardly any or none

30. On average, how many hours of sleep do you get in a 24-hour period?

- Less than 5 5-6 7-9 More than 9

Substance Use

31. How would you describe your cigarette smoking habits?

- Never smoked
 Used to smoke. How many years has it been since you smoked? _____ years
 Still smoke. How many cigarettes a day do you smoke on average? _____ cigarettes/day

32. How many alcoholic drinks do you consume? (A "drink" is a glass of wine, a wine cooler, a 16oz bottle/12oz can of beer, a shot glass of liquor, or a mixed drink).

- Never use alcohol Less than 1 per week 1-6 per week
 1 per day 2-3 per day More than 3 per day

33. In one sitting, how many drinks do you typically consume? _____

34. How many cups (8 ounces) of coffee do you drink per day? _____

35. How many ounces of sodas containing caffeine do you drink per day? _____

Physical Fitness, Physical Activity/Exercise

36. Considering a **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your **free time** (write on each line the appropriate number).

- | | Times Per Week |
|--|-----------------------|
| a) STRENUOUS EXERCISE (HEART BEATS RAPIDLY)
(i.e. running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling) | _____ |
| b) MODERATE EXERCISE (NOT EXHAUSTING)
(i.e. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing) | _____ |
| c) MILD EXERCISE (MINIMAL EFFORT)
(i.e. yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking) | _____ |

37. Considering a 7-Day period (a week), during your leisure-time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

- OFTEN SOMETIMES NEVER/RARELY

38. How long have you exercised or played sports regularly?

- I do not exercise regularly Less than 1 year 1-2 years
 2-5 years 5-10 years More than 10 years

39. Please describe your regular physical activity during a typical week. Please include the intensity, duration, and type of activity. If you do not exercise, write "none".

	Activity	Duration (time)	Intensity
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

Occupational Health

40. Please describe your main job title and duties.

41. How much hard physical work is required on your job?

- A great deal A moderate amount A little None

Appendix B

Yoga Experience Questionnaire

1. Have you ever participated in yoga exercise? Yes No
2. Are you currently participating in yoga exercise? Yes No

If 'Yes', please indicate years of experience: _____

3. According to the chart below, please rank your participation in yoga exercise over the last 12 months: _____

Rarely	Occasionally	Regularly
Not More Than 1 Session per <i>Month</i>	Not More Than 1 Session per <i>Week</i>	3 or More Sessions per <i>Week</i>

4. If you answered 'Rarely' to question 3. In the past, has your participation ever qualified in a different rank category? If so, please indicate which one: _____
5. Do you practice Bikram Yoga or any other form of hot yoga? If so, please rank your current participation: _____

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Vita

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