Cardio-Pulmonary Physiology during Yoga Inversion Practice

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Abstract

Introduction: Mass media advertisements have claimed health benefits of body inversion for relaxation and cardiovascular conditioning. We conducted a preliminary study to evaluate real time physiological changes and responses to mediation, Hatha yoga, and specifically inversion and standing postures to determine the O₂ consumption recorded by a wearable metabolic device and cardiovascular measures.

Methods: Healthy study volunteers executed a sequence of yoga postures that included inversions of whole body while wearing a Cosmed K5 portable metabolic backpack. We obtained brachial blood pressure during the last 30 seconds of each posture. Each trial began seated, followed by a warm-up consisting of gentle flow yoga and ending with relaxation. **Results:** Twelve experienced yoga practitioners (mean age 44 years, 58% female) participated in 17 trials. Over all trials, mean VO₂ for Sirsasana as compared with the supported inversion posture decreased from 8.4 to 4.9 (ml/kg/min). **Conclusions:** Conflicting findings exist in the literature concerning inversion physiology. Cardiac output response to inversion is not consistent in scientific reports. Participants responded differently under a variety of circumstances in previous studies, making comparisons to this and existing research challenging. We find sufficient cause for further research and suggest that some forms of inversion may be beneficial to heart failure patients.

Keywords: yoga, inversion, cardiopulmonary, heart failure, physiology

Introduction

Recent advertisements have claimed health benefits of body inversion for stress reduction and cardiovascular conditioning in mass media (Yoshikawa, 2017). Inversion and head-down tilt were initially introduced as laboratory methods for studying physiologic changes, utilized to simulate weightlessness in space (Blomqvist et al., 1980). Historically, inversion has been widely used as a therapeutic modality to resolve musculoskeletal back pain (deVries & Cailliet, 1985). Inversion while performing vertical head-down sit-up exercises at various degrees was reported to effect the strengthening of abdominal muscles (Klatz, 1983; Boone & Johns, 1989).

Several studies have examined inversion therapy for a variety of cardiopulmonary disorders, including pulmonary emphysema, hypertension, coronary artery disease, and heart failure (Alvan et al., 1954; Klatz et al., 1985; Yadav et al., 2015; Pullen et al., 2018). We conducted a preliminary study to evaluate real time physiological changes and responses to meditation, Hatha yoga, inversion postures and standing postures to determine oxygen consumption (VO_2) and other cardiopulmonary variables utilizing a wearable metabolic device (Conroy et al., 2019). This effort was to evaluate the appropriateness of inversion with heart failure (HF) patients, requiring a physical regime characterized by low VO_2 and low impact (Pullen et al., 2010).

Oxygen Consumption and Yoga

Hatha yoga is one style of yogic practice that traditionally lasts up to 90 minutes and typically involves a series of asanas (poses or postures) with Pranayama (breath control/exercises) and Savasana (corpse pose/relaxation). Depending on the style of yoga, studio, or teacher, a yoga session typically involves standing, seated, or supine asanas held for various amounts of time. The practice of yoga often involves balance and inversion poses with focus on proper form, alignment, and breathing. Yoga has emerged in new-generation active computer games called exergames with Microsoft Kinect and Wii Fit software platforms (Pullen & Seffens, 2018). Energy cost as O_2 consumed per kg body mass per minute

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and metabolic equivalents (METs, where 1 MET $\sim$ 3.5 ml/kg/min for average resting O₂ consumption) of individual yoga asanas has recently been systematically reviewed (Larson-Meyer, 2016). Eight studies found in the literature examined the metabolic cost of several yoga asanas held in traditional yoga

Figure 1.
Portable metabolic K5 measurements during yoga.

postures. Standing asanas displayed slightly higher average MET values than seated poses. Average METs of supine poses (*i.e.*, Savasana or corpse pose) were similar to average resting values (MET value at rest = 1). Inversion poses, including Sirsasana (headstand) did not increase metabolic rate higher than 1.7 to 2.5 METs. Metabolic cost of some of the more difficult inversions/arm balancing poses, including Bakasana (crow/crane), Eka Pada Galavasana (flying pigeon), and Adho Mukha Vrksasana (handstand), produced MET values >3 (*ibid.*).

Physiology of Inversion

Sympathetic and parasympathetic nervous system (PNS) impulses balance the cardiopulmonary response and blood flow when changing from standing to supine body positions (Birjiniuk, & Heldt, 2019). Hydrostatic pressure of a liquid is greater at the base of a column as the liquid above weight increases. This implies when standing in upright position, blood pressure (BP) tends to be greater in the feet than in the head. Hydrostatic pressure also explains that during inversions pressure and blood flow increase in the chest and head along with decreased resistance to draining into the great veins leading to the heart's right atrium. In other words, venous return (preload) is augmented due to gravity when the legs are above chest height. Previously, we conducted a case study (Figure 1) to evaluate real time physiological changes and responses to Hatha yoga inversion and standing postures as a control to determine VO₂ and BP while wearing a wearable metabolic device. Following the protocol of the case study, we conducted a more

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robust clinical study to evaluate real time physiological changes among a group of healthy volunteers (Conroy et al., 2019).

Cardiovascular Effects of Inversion

There are few published studies on the intersection of yoga and cardiopulmonary physiology of body inversion. Generally, yoga physiology research papers have focused on either cardiovascular or pulmonary measurements in disease states, this research paper examined both simultaneously in normal subjects. Several discordant measurements appear in the findings of cardiovascular measurements with inversion postures. Heng et al., (1992) reported a significant increase in HR during inversion relative to standing, while other researchers have reported a decrease (deVries & Cailliet, 1985; Sfakianos et al., 1985) or no change in HR (Cardus et al., 1984; Jennings et al., 1985; London et al., 1983). Research on cardiac output (CO) response to gravity inversion is conflicting. Cardus et al. (1984) and Haennel et al. (1988) reported an increase whereas, Heng et al., (1992) reported a decrease. A decrease in systolic blood pressure (SBP) was reported by Wilkins et al. (1950), while Klatz et al., (1983 & 1985; LeMarr et al., 1983) reported an increase or no change during inversion as cited in Haennel et al. (1988). Clearly, subjects in different studies responded differently under a variety of circumstances and protocols. Additionally, the variety of apparatus utilized to measure inversion responses accounts for some of the physiology differences. More recently, Papp et al. (2013) performed a small-scale longitudinal study in naive yoga practitioners, where inversion time increased from seven minutes to 20 minutes over eight weeks and found increased heart rate variability (HRV). This implies that yoga practice can have a beneficial effect on the autonomic nervous system.

With primary focus on the body, breath and mind, yoga is psychophysical in character. Focusing on one's own breathing while practicing yoga body movements, and vice versa, can function as a tool to increase awareness of tension/relaxation states. Thus, increased awareness of body orientation in space is an effective biofeedback instrument. Many of the slow movements in yoga relate to natural

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synchronization between breathing and moving (flow yoga) which promotes slower, deeper and more even paced breathing. In turn, this induces parasympathetic nerve activity and a feeling of relaxation, which can influence HR, BP and breathing pace (Bernardi et al., 2001). Supine and inverted body postures stimulate the baroreceptor reflex (from altered negative pressure in the upper body) and may create parasympathetic (vagal) activity, while upright postures inhibit it. The baroreceptor reflex is involved with HR regulation and closely links to the PNS (Selvamurthy et al., 1998; Cole, 1989).

Pulmonary Effects of Inversion

The physiology of the cardiopulmonary system is well known. The lungs linked in series with heart circulation are mechanically influenced by the dynamics of cardiac contraction and by cytokines and neuro-humoral modulators involved in cardiopulmonary functions. In a 3-month, randomized controlled study of yoga's effect on pulmonary function parameters, Yadav et al. (2015) studied pulmonary responses in coronary artery disease (CAD) patients and included several supine and prone postures. They reported statistically significant improvement in most of the pulmonary parameters measured, including forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), peak expiratory flow rate (PEFR), and maximum voluntary ventilation (MVV). Yadav proposed that reduction of sympathetic reactivity attained with yogic training facilitates broncho-dilatation by correcting the abnormal breathing patterns and reducing the muscle tone of inspiratory and expiratory muscles. Due to improved breathing patterns, respiratory bronchioles may be relaxed and perfusion of alveoli carried out more efficiently (Abel, 2013).

From standing to a supine position, there is only a slight decrease in total lung capacity, residual volume, and vital capacity, but with a large decrease in expiratory reserve volume without an increase in inspiratory reserve volume (Attinger et al., 1956). Pulmonary mixing was diminished in the supine compared to the erect position (Blair & Hickam, 1955). Changes in hydrostatic pressure and gravity

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influence the physiology of the lung directly by influencing perfusion-ventilation exchange and the distribution of pulmonary blood flow.

The purpose of this study was to address some of the discordant results with yoga inversion in the literature and to consider specific benefits to heart failure patients needing low VO_2 demand restorative exercise.

Methods

The University of North Georgia's (UNG) Institutional Review Board (IRB) approved the study, effective 12/06/2018 with Protocol Code: 2018-196. This study was expanded from the initial case study

Figure 2.
Headstand wearing metabolic device

to a more robust clinical study by amending the protocol for 10-20 participants, approved by UNG-IRB 2020. A convenience sample from a population of yoga students that regularly attended Iyengar yoga classes at a yoga studio in Atlanta, Georgia were invited to participate in the study. Inclusion criteria was minimum of two years of yoga practice, including inversions. A portable metabolic device (Cosmed K5), calibrated according to manufacturer's specifications, was worn for the duration of each trial (Figure 2).

A yoga teacher (RYT® 500-Yoga Alliance) led each participant in a sequence of postures that included whole body inversions. Each half-hour trial followed a specific protocol (Appendix A) with the order between inversion and standing postures alternating. Brachial BP was obtained using an AlphaMed fully automatic blood pressure monitor (Model U80R) during the last 30 seconds of each posture. Heart rate, VO_2 and Respiratory Quotient (RQ) were recorded every 10 seconds by the metabolic device. The trial began with a two-minute crossed leg pose, followed by a warm-up consisting of breathing exercises and a dynamic sequence of postures. The second sequence included Tadasana (mountain pose) then Utkatasana (chair pose) held for two minutes each. For the

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third sequence, Viparita Karani and Sirsasana were performed in place of the standing postures, each for four minutes and ended with Savasana (corpse pose) for relaxation (see protocol, Appendix A).

Analysis followed the sequence A->B->C corresponding to standing (A), supine (B) and inverted (C) postures. Related cardiovascular responses were calculated according to the formulas below (Koenig et al., 2015):

- (1) Stroke volume (SV) calculated by dividing pulse pressure (SBP-DBP) by (SBP+DBP)
- (2) Cardiac output equals SV x HR
- (3) Arteriovenous oxygen difference calculated by dividing oxygen uptake by CO
- (4) Mean arterial pressure (MAP) calculated using the formula:
$$\text{MAP} = \text{DBP} + .32(\text{SBP} - \text{DBP})$$
- (5) Systemic vascular resistance (SVR) calculated by dividing MAP by CO

Statistics: Student's t-test determined significance of change in the cardiovascular responses between postures A->B, A->C, B->C, or A->C. The alpha level was set at 0.05 for statistical significance.

Results

Twelve yoga practitioners (mean age 44 years, 58% female) participated in 17 trials recording changes in BP, VO_2 , RQ and related METs (Table 1). Systolic blood pressure ranged from 152 mmHg for Sirsasana to 125 mmHg for Savasana, while the associated diastolic blood pressure (DBP) ranged from 103 to 77 mmHg. A t-test between meditation and inversion for VO_2 and HR was significant ($p < 0.05$). As

Table 1
Comparisons Across Yoga Postures

Yoga Pose	SBP	DBP	RQ	VO_2	METs	HR
Sirsasana	151.8	103.2	0.91	8.44	2.41	80.9
Utkatasana	140.4	94.4	0.85	10.14	2.90	104.9
Warm-up	136.9	87.8	0.81	11.53	3.29	99.0
Tadasana	136.2	88.4	0.99	7.59	2.17	84.2
Study Start	132.4	83.5	0.78	5.41	1.55	74.4
Pranayama	131.0	85.8	0.80	4.40	1.24	75.1
Viparita Karani	130.2	78.4	0.94	5.31	1.52	67.9
Savasana	125.2	76.8	0.95	4.90	1.42	71.8

Notes. Prana = Pranayama-breathing exercises; Viparita Karani or legs up the wall (a supported inversion). Savasana= resting or corpse pose; SBP= systolic blood pressure; DBP = diastolic blood pressure; RQ= respiratory quotient; VO_2 as relative oxygen consumption in ml/kg/min; METs=metabolic equivalents; HR=heart rate in beats per minute.

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with another study (Heng et al., 1992), BP was elevated during inversion. Our initial case study (Conroy et al., 2019) found a mean VO_2 /kg of 3.1 ± 0.08 for the meditative pose, while the inverted poses yielded a mean VO_2 of 19.5 ± 1.5 ml/kg/min. A RQ of less than 0.8 indicates primarily fat utilization for energy, so the participants arrived at the trial burning fat stores; while during the trial, carbohydrate metabolism dominated ATP production. Oxygen consumption or METs corresponded roughly with SBP. The highest energy pose was the warm-up phase at 3.1 METs, followed by the difficult Utkatasana and closely behind was Sirsasana at 2.4 METs. Heart rate generally followed SBP. Heart rate response ranged

Table 2

Statistical comparisons between yoga poses for primary variables

Yoga Posture	SBP	DBP	VO_2	HR
Viparita Karani	131	80	5.3	70
Sirsasana	154	105	8.3	82
<i>Compare 2 C t-test</i>	0.071	0.005	0.000	0.000
Tadasana	131	87	7.4	84
Sirsasana	152	110	9.1	82
<i>Compare A->C t-test</i>	0.101	0.004	0.001	0.569
Utkatasana	131	91	10.4	104
Sirsasana	155	108	8.6	78
<i>Compare A->C t-test</i>	0.100	0.159	0.032	0.000
Savasana	127	73	8.3	81
Viparita Karani	130	78	5.3	68
<i>Compare B->C t-test</i>	0.735	0.035	0.000	0.000
Savasana	121.2	74.7	5.0	70.3
Sirsasana	159.4	107.7	8.3	81.5
<i>Compare B->C t-test</i>	0.009	0.002	0.001	0.002
Tadasana	130.5	85.6	7.4	83.4
Viparita Karani	126.9	76.7	5.7	66.7
<i>Compare A->C t-test</i>	0.296	0.049	0.002	0.000
Study Start	129	84	8.4	79
Savasana	125	76	5.4	72
<i>Compare B to Start t-test</i>	0.564	0.044	0.000	0.008
<i>P<0.05</i>				

Note. SBP= Systolic blood pressure; DBP= Diastolic blood pressure; HR = Heart rate; VO_2 = ml/min/Kg; Paired t-test of comparisons between positions A standing, B supine, and C inverted. Parameter means can be different due to some missing values that occurred during some trials.

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from 105 beats per minute (bpm) for Utkatasana to Savasana (resting) at 72 bpm.

Over all trials, mean oxygen consumption for Sirsasana as compared with supported inversion posture decreased from 8.4 to 4.9 ml/kg/min. Significance of comparing various poses on body position transitioning from standing to inverted are shown in Table 2. A t-test between Sirsasana and Viparita Karani for VO₂ consumption, HR, and DBP were significantly different ($p < 0.005$). All variables in Table 2 comparing supine resting (Savasana) and Sirsasana, were significantly different ($p \leq 0.009$). There are also significant differences for all values except SBP, between Tadasana and Karani, as well as study start and Savasana ($p < 0.05$). Comparison of Utkatasana to Sirsasana pose follows the sequence of standing to inversion (A->C), while Tadasana/Savasana/ Viparita Karani follows the sequence of standing/ supine/inversion (A->B->C). Comparison t-tests were run paired, so the means shown in Table 2 are often.

Measurements of CO and other derived hemodynamic variables obtained from HR and blood pressures (SBP and DBP) shown in Table 3. Comparisons of physiological responses to standing, supine and supported inversion were made between the current and previous studies (Boone, 2002; Heng et al., 1992). Heart rate emerged as the

Table 3
Three Body Positions Comparison with Literature Trends

Body position	SBP	DBP	HR	VO ₂ mL/Kg/min	RPP	SV	CO	MAP	SVR
Tadasana	136	88	84	7.59	<i>11582</i>	<i>0.21</i>	<i>17.2</i>	<i>103.7</i>	<i>6.01</i>
Savasana	125	77	72	4.90	<i>8987</i>	<i>0.24</i>	<i>16.8</i>	<i>92.3</i>	<i>5.51</i>
Viparita Karani	130	78	68	5.31	<i>8922</i>	<i>0.25</i>	<i>16.9</i>	<i>95.0</i>	<i>5.62</i>
<i>Trends</i>									
This Study	0	↓	↓	↓	↓	0	0	↓	0
Boone	0		↓	0		↑	↑	0	↓
Heng	↑	↑	↑		↑		↓		↑

Notes. Numeric values in black are actual measurements; numbers in italics are derived values. Trends are for standing, supine, and inverted orientations: ↑ = increase, 0 = statistically no change, ↓ = decrease. For This Study row, at least 2 out of the three position transitions must be significant (A->B, A->C, B->C) to determine a trend.

variable that decreased going from standing to supine to inversion for both this study and Boone's study. Within this study, BP, HR, VO₂, rate pressure product and MAP decreased significantly going from standing to inversion whereas, SBP, SV, CO and SVR remained unchanged.

Yoga Exergames and Energy Expenditure

Exergaming is a term used for video games that are also a form of exercise. Exergaming uses technology that tracks body movement, which has upending the stereotype of gaming as a sedentary activity. Systems such as Xbox use input devices like the Kinect sensor that measures and scores movement then superimpose animated objects or avatars to interact with over a video image of the user (Pullen & Seffens, 2018). In order to estimate energy expenditure during an exergame yoga session, we earlier measured O₂ consumption rates and METs for selected yoga postures (Table 4) using a Parvo Medics TrueOne 2400 metabolic cart (Pullen et al., 2015). Setup and calibration were conducted as detailed in operating manual. We measured O₂ consumption for a series of yoga positions as mentioned previously (ibid.). As expected, more intense positions have higher energy consumption. Difference between the average MET for Tadasana in Table 4 (at 1.46) with the value of 2.0 in Table 1 is probably due to the different metabolic carts (Parvo Medics vs Cosmed K5) utilized between these studies.

Table 4
Metabolic Equivalents (METs) for Yoga Postures

Subject	Gender	Age	Standing	Mountain	Arms Up	Warrior	Rev-W
1	F	57	0.95	1.55	1.5	1.8	2.3
2	M	61	1.03	1.15	1.35	2.05	2.35
3	M	21	1.32	1.1	1.7	2.25	2.55
4	F	21	1.35	2.05	1.9	1.95	2.65
5	M	26	1.07	1.2	1.15	1.75	2
6	M	21	1.5	1.75	1.25	2.9	3.8
AVG	M	34.5	1.2	1.46	1.48	2.12	2.61

Note. Standing is relaxed; Mountain is Tadasana which engages postural support muscles; Warrior is Virabhadrasana I; Rev-W is Viparita Virabhadrasana (Pullen, et al., 2015).

Discussion

Consistent with Boone (2002), cardiac output increased with supine versus standing and during the inverted versus supine and standing, although not statistically significant. Increased CO directly related to a reduction in the effects of gravity in standing and seated positions, may promote blood pooling in the lower extremities. Since the supine position effectively neutralizes gravity effects on the cardiovascular system, the transition from standing to supine presumably increases venous return, end-diastolic volume, and therefore stroke volume (SV in Table 3). With subjects in the inverted position, the effect of gravity should also increase venous return. Since the subjects' HR decreased from standing to supine (transition A->B) and inverted positions (transition B->C), and yet CO remained nearly constant as shown in Table 3, then stroke volume correspondently increased.

The paucity and diversity of scientific studies in the literature concerning body inversion, specific to the practice of yoga postures highlights the need for future research. Heng et al., (1992) reported a significant increase in HR during inversion relative to standing, while other researchers have reported a decrease (Table 3 in this study) or no change in HR. The CO response to inversion in the present study remained the same. Similarly, systolic blood pressure (SBP) previously reported to increase or decrease or did not change significantly with inversion (Haennel et al., 1988). The variety of protocols and circumstances these few studies reported, may be explained by the different protocols and participant experience with inversion and highlights the need for protocol standardization and clinically specific population studies. For these reasons, comorbidities such as, hypertension, history of stroke or heart disease warrants a cautious approach when engaging with inversion postures. Our previous study with HF patients did include Viparita Karani with BP checks without adverse events (Pullen et al., 2010).

Boone's study (2002) of fourteen healthy subjects used a gravity-inversion apparatus with the subjects standing upright for five minutes. Resting BP and HR were measured after four minutes while CO was measured at the fifth minute. This was repeated for the horizontal pose (supine B position) and

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subject was rotated to a 45-degree head-down position for the final five minutes. Transitioning from standing to supine (A->B) to head-down (B->C) did not alter O₂ consumption nor mean arterial pressure. Cardiac output and SV increased in supine position (A->B) and increased further with the inversion (B->C) positioning. Heart rate decreased during supine and inverted positions. Systemic vascular resistance decreased during the supine position (A->B) and decreased further during the inverted position (B->C). Systolic blood pressure increased from inversion relative to standing and supine. Boone concluded that O₂ consumption was not altered depending on whether they were standing, supine, or in an inverted position. With VO₂ unchanged, the increase in CO was balanced by a decrease in extraction of oxygen by the body.

Adverse Events with Yoga Inversions

Yoga is regarded as beneficial to most people, yet the safety of yoga has been questioned in some popular-press articles, prompting a systematic review by Cramer et al., (2013) that included 76 cases of adverse events associated with yoga. Sirsasana and Salamba Sarvangasana (supported shoulder stand) were the most often-cited yoga postures associated with adverse events. Yoga instructors, assumed to practice more intensely than yoga students do, have reported adverse events. Two of the three cases who had practiced Salamba Sarvangasana and eight of the ten cases that had practiced Sirsasana reported orbital adverse events, mainly glaucomatous symptoms (*ibid.*). While there are reports that Sirsasana induces a twofold increase in intraocular pressure, values returned to baseline promptly afterwards, and association of regular yoga practice with chronically increased intraocular pressure was not found (Baskaran et al., 2006).

Little evidence exists regarding the relationship between inversions and other pre-existing conditions. Therefore, all yoga students with comorbidities should be cautious with inversions, which may be contraindicated for individuals with a history of glaucoma. As with any other physical or mental practice, yoga is not without possible risk. Given the large number of yoga practitioners worldwide,

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relatively few serious adverse events have been reported. The conclusion of a systematic review and meta-analysis of yoga for chronic disease management was that the practice of yoga significantly improved exercise capacity and reported quality of life (Desveaux, Lee, Goldstein & Brooks, 2015).

Conclusion

Physiological responses varied between meditation Hatha yoga, inversion (experimental) and standing postures (control). Reliability and validity of portable VO_2 and rate pressure product measurements made during yoga postures were examined in a cohort of experienced yoga practitioners. These results add to broader aspects of yoga and physiological measurements discussed above with further trials and additional subjects planned. This platform of inquiry may be utilized for teaching physiology to kinesiology students and assist in implementation of yoga and other meditative movement technologies.

Evidence of discordant findings exist in the literature concerning physiology of inversion. The CO response to inversion has been reported as increased or decreased. Participants responded differently under a variety of protocols in previous studies, making comparisons to existing research challenging. We recommend further research on the physiological response to supported inversion postures with cohorts of targeted populations such as heart failure patients be investigated for therapeutic outcomes.

Conflict of Interest to Declare

The authors have no conflicts of interest to disclose.

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Appendix

*Yoga Inversion Study Protocol: Physiological Measurements during Yoga© by Dr. Paula Pullen (aka Seffens)

Subject ID: _____ Date: _____ Weight: _____ lbs. _____/2.2= _____ kg Height: _____ cm _____ M or F

PRE-TRIAL ACTIVITY

- ☐ K5 warm-up for 20 min. ☐ K5 Calibrated ☐ VO₂ Mask Set-Up ☐ HR monitor on participant ☐ K5 fitted
☐ Participant seated on floor in comfortable position (support as needed in cross leg pose- Sukasana)
☐ Start K5 and allow 2 min for calibration (after 2 min, time will restart at 0:00)

TRIAL

- ☐ Start time on K5 clock: _____ (Use stopwatch to measure individual time segments)
Baseline: BP on Right Arm then Left Arm: (R) _____/_____ mm Hg (L) _____/_____ mm Hg
[Standardize all BPs to left arm unless >10mm difference noted at start which is a study exclusion criteria.]

PRANAYAMA & ASANA- WARM-UP (SEQUENCE ONE)

- ☐ Start 3 rounds of breathing exercise while seated (Pranayama- equal inhale & exhale duration)
☐ Start time on K5 clock: _____
Post-Pranayama BP: _____/_____ mm Hg Time B/P obtained: _____
From Tadasana (standing Mountain pose)
☐ Start 3 rounds moving from Urdhva Hastasana (Upward Salute) to Uttanasana (standing forward bend) to
Adho Mukha Svanasana (Downward-Facing Dog Pose) ☐ Start time on K5 clock: _____
☐ BP immediately upon stopping: _____/_____ mm Hg ☐ End Time on K5 clock: _____

ASANA POSTURES (SEQUENCE TWO)

1. Utkatasana (Chair Pose- Arms above Head) – 2 min ☐ Start Time on K5 clock: _____
☐ Begin BP during last 30 seconds: BP: _____/_____ mm Hg ☐ End Time on K5 clock: _____
2. Tadasana (Mountain Pose) – 2 min ☐ Start Time on K5 clock: _____
☐ Begin BP during last 30 seconds: BP: _____/_____ mm Hg ☐ End Time on K5 clock: _____

INVERSIONS (SEQUENCE THREE)

1. Sirsasana (Head stand) – 4 min ☐ Start Time on K5 clock: _____
☐ BP one: start at minute 1'30" _____/_____ ☐ BP two: start at minute 3'30" _____/_____
☐ End Time on K5 clock: _____
2. Viparita Karani – (Legs on the wall- hips supported by a 4-5 inch thick bolster) - 4 min
☐ BP one: start at minute 1'30" _____/_____ ☐ BP two: start at minute 3'30" _____/_____
☐ End Time on K5 clock: _____

RELAXATION (SEQUENCE FOUR)

- ☐ Savasana (corpse pose) – 5 minutes
Start time on K5 clock: _____
☐ Begin BP in last 30 seconds: Min 2 BP: _____/_____ mm Hg ☐ End Time on K5 clock: _____

Stop the K5 clock!

*Contact Dr. Pullen to obtain permission to use this protocol for research purposes at paula.seffens@ung.edu