5-2018

THREE SPEEDS OF YOGA AND THE EFFECTS ON SALIVARY CORTISOL LEVELS IN FEMALE NURSING STUDENTS

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By

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THESIS

Submitted to
Northern Michigan University
In partial fulfillment of the requirements
For the degree of

MASTER OF SCIENCE IN EXERCISE SCIENCE

Office of Graduate Education and Research

March 2018

SIGNATURE APPROVAL FORM

THREE SPEEDS OF YOGA AND THE EFFECTS ON SALIVARY CORTISOL IN FEMALE NURSING STUDENTS

This thesis by Meagan R. Hennekens was recommended for approval by the student's Thesis Committee and Department Head in the School of Health and Human Performance and by the Assistant Provost of Graduate Education and Research.

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ABSTRACT
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Purpose: Nursing students are prone to stress-related diseases, such as depression and anxiety, which are associated with chronically elevated cortisol levels due to the excessive firing of the Hypothalamic Pituitary Adrenal (HPA) axis. This study assessed three speeds of yoga and how they acutely affected salivary cortisol levels within female nursing students. **Methods**: Students participated in three yoga sessions cadenced at different speeds in a non-randomized order: (i) standard-speed yoga (SSY), (ii) high-speed yoga (HSY), and (iii) slow-speed yoga (SLSY). Each class integrated sequencing concepts from the *brahmana/langhana* strategy (BLS) and the Para Yoga Blueprint (PYB). Cortisol samples were collected at four time-points: (i) pre-*asana* (PREA), (ii) immediately post-*asana* (POA), (iii) immediately post-*savasana/pranayama/dhyana* (POSPD), and (iv) 15 min post-session (15-PO) during all three yoga sessions. **Results**: ReANOVA showed no significant differences in cortisol within the main effect of yoga speeds ($p = 0.094$) or between the yoga speed x time-points interaction ($p = 0.231$). The main effect across the four time-points were significantly different from each other ($p < 0.001$) and pairwise comparison showed significant decreases in cortisol from the PREA measurements to the three post-measurements ($p = < 0.05$). **Conclusions:** Yoga infused with PYB and BLS sequencing reduced salivary cortisol in nursing students. Further research may identify appropriate yoga interventions to help mitigate stress and prevent chronic stress-related disease in nursing students.

DEDICATION

To the connection of Eastern and Western sciences.

ACKNOWLEDGMENTS

A sincere thank you doesn’t even skim the depths of gratitude I have for my thesis committee: director, Dr. Lanae Joubert, for her guidance, patience, and infinite support; Dr. Erich Ottem, who planted the seed of science about human physiology and endocrinology; and Dr. Scott Drum, for motivation, direction, and encouragement along the way. Other professors I would like to acknowledge are as follows: Dr. Randall Jensen and Dr. Alan Rebertus for help with the statisitics portion of this project and Dr. Paul Mann for guidance in the Clinical Sciences Lab.

Deep bows of gratitude to Karina A. Mirsky, my yoga teacher, who has encouraged me to seek my passion of connecting the ancient wisdom of the Eastern yogic philosophies to the Western science world.

I have an infinite amount of appreciation for the financial support received from my parents, Carol and Jeff Hennekens; Northern Michigan University; Superior Health Foundation; Rohana Yoga & Wellness; and Northstar Investment Management. Without these amazing people and thoughtful organizations, this project would not have been possible.

Last, but definitely not the least, I am extremely grateful for the subjects who participated within the study. Without you, there wouldn’t be an experiment to write about.

PREFACE

The cost of the research covered in this project was underwritten by grants from two organizations: (A) Excellence in Education Award of $1,500.00 from Northern Michigan University & the Fall 2017 Grant of $276.82 from the Superior Health Foundation.

This thesis document follows the format prescribed by the Office of Graduate Education and Research and of the School of Health and Human Performance at Northern Michigan University. Chapter I is written in journal-ready format for the Journal of Holistic Nursing (JHN) and uses the American Psychological Association (APA) citation format. Review the JHN submission guidelines here.

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LIST OF DEFINITIONS

Sanskrit - English

- *Yoga* – 'Union, yoke' of the body, mind, and spirit
- Patanjali's Traditional 8 Limbs of Yoga
    - *Yamas* - Moral code
    - *Niyamas* - Personal conduct
    - *Asana* – Physical posture(s)
    - *Pranayama* – Breathwork
    - *Pratyahara* – Sense withdrawal
    - *Dharana* - One-pointed focus
    - *Dhyana* – Meditation
    - *Samadhi* - Union, absorption
- *Vinyasa* – Linking breath with movement
- *Brahmana* – To build up, energize
- *Langhana* – To reduce, calm
- *Yoga Nidra* – Yogic sleep, type of relaxation technique
- *Anamaya Kosha* - Physical body
- *Gunas* – Energetic qualities of the mind
    - *Sattva* – Equilibrium
    - *Raja* – Activity
    - *Tama* – Stability
- *Kriya* – Orchestrated pattern of movements, sounds, and breathwork
- *Kaya Sthira* – Complete comfortable stillness
- *Shavayatra* – Inner pilgrimage through the body; 31/61 points relaxation technique
- Names of *Asanas* **-**
    - *Bharadvajasana I* – Seated cross legged twist
    - *Parsva Sukhasana* – Seated cross legged lateral stretch
    - *Marjariasana* – Cat/cow
    - *Adho Mukha Shvanasana* - Downward facing dog
    - *Chaturanga Dandasana* - Four-limbed staff pose

- *Ashtanga Namaskara* - Knees-chest-chin pose
- *Balasana* – Child's pose
- *Anjaneyasana* – Low lunge pose
- *Bhujangasana* – Cobra pose
- *Salamba Bhujangasana* – Sphinx pose
- *Surya Namaskar C* – Sun Salutation C (classic)
- *Alanasana** - Crescent lunge/high lunge (*no official name in Sanskrit)
- *Virabhadrasana I* – Warrior I pose
- *Utkatasana* – Chair pose
- *Prasarita Padottanasana I* – Standing wide legged forward fold
- *Upavistha Konasana* – Seated wide legged forward fold
- *Malasana* – Deep squat
- *Salabhasana* – Locust pose
- *Marichyasana III* – Sage's pose – seated twist with one leg extended forward
- *Janu Sirsasana* – One legged seated forward fold
- *Ardha Ananda Balasana* – Half happy baby pose static
- *Ananda Balasana* – Happy baby pose

CHAPTER I: RESEARCH EXPERIMENT

BACKGROUND & PURPOSE

STRESS & NURSING STUDENTS

Stress is triggered by a biological, environmental, social, emotional, or psychological event (García-Sesnich, Flores, Ríos, & Aravena, 2017). Nursing students commonly experience stress (76%), depression (62%) (Papazisis, Nicolaou, Tsiga, Christoforou, & Sapountzi-Krepia, 2014), and anxiety (53%) (Bayoumi, Elbasuny, Mofereh, Assiri, & Fesal, 2012). High amounts of repetitive stress can be attributed to their rigorous academic loads and competitive educational environments. Additionally, nursing students commonly have negative stress coping habits; including drinking alcohol (80%), using illegal drugs (19%) (Stecker, 2004), and smoking tobacco (18%) (Fernández, Ordás, Álvarez, & Ordóñez, 2015). These alarming statistics highlight the essential need for healthy stress management interventions within future healthcare professionals to prevent stress-related disease. Nursing students and healthcare professionals hold an inherent responsibility to make healthy choices. By developing healthy stress coping habits, nursing students can lead by example and teach their future patients from personal experience (Stark, Manning-Walsh, & Vliem, 2005).

Cortisol is an important metabolic regulation hormone and is a common physiological biomarker in stress research. Baseline cortisol levels are controlled by a diurnal circadian rhythm or the mammalian sleep-wake cycles (Li & Goldsmith, 2012). A normal diurnal rhythm expresses cortisol concentrations peaking within 20-60 minutes after waking, known as the cortisol awakening response (CAR) (Anderson & Wideman, 2017; Clow, Thorn, Evans, & Hucklebridge, 2004). By mid-afternoon, the concentration is reduced by half, then continues to lower throughout the evening, finally reaching the lowest concentration by midnight (Butzer et al., 2015; Matousek, Dobkin, & Pruessner, 2010).

In an acute response to a painful or non-painful stressor, secretion of the glucocorticoid hormone, cortisol, is subsequent to the neural fight-or-flight survival response of the sympathetic nervous system (SNS) (Kudielka, Hellhammer, & Wüst, 2009). The autonomic nervous system (ANS) determines what is stressful, stimulates the amygdala of the limbic system and the paraventricular nucleus (PVN) of the hypothalamus. The PVN activation triggers the hypothalamic pituitary adrenal (HPA) axis to produce and release cortisol into the bloodstream (Thirthalli et al., 2013). Then, under normal homeostatic conditions, the high concentrations of cortisol signal the HPA axis to downregulate the secretion of the hormone once the stressor is removed (Holsboer, 2001; Whitworth, Williamson, Mangos, & Kelly, 2005).

Chronic exposure to stressors lead to HPA axis overstimulation and cortisol dysfunction, which distinguishes between chronic and an acute stress responses. See summarized acute and chronic stress response in Figure 1.1 created by Hannibal & Bishop (2014) below.

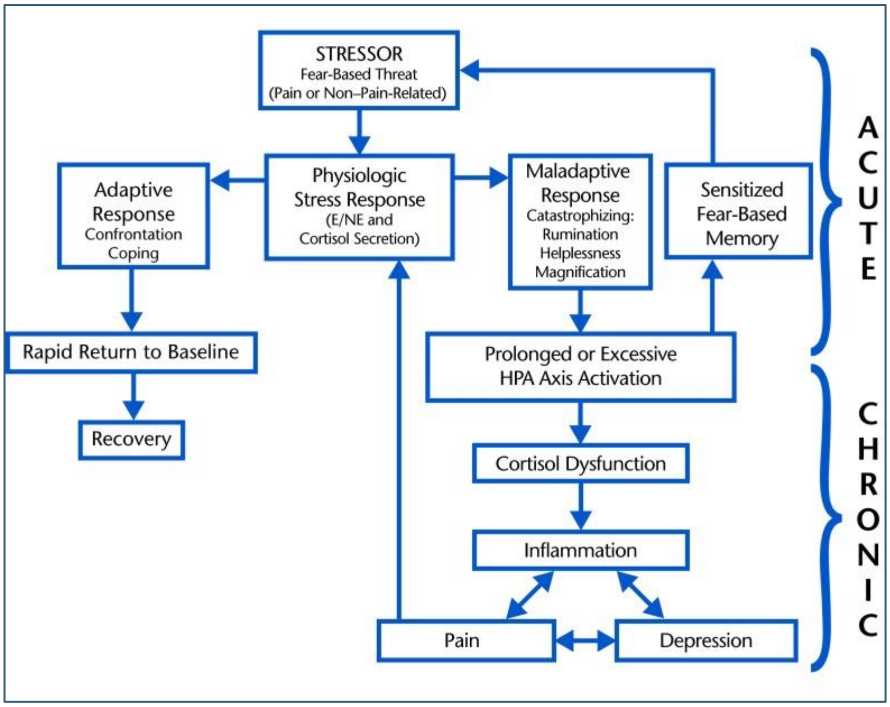

Figure 1.1 – Acute and Chronic Stress Reponses – This flow chart displays the differences between acute (short-term SNS and hormonal activation/recovery) and chronic (cortisol dysfunction) stress responses. Permission for reuse from Hannibal & Bishop (2014).

When presented with a stressor, the SNS causes the release of norepinephrine (NE) and epinephrine (E) followed by the secretion of the hormone, cortisol. With adaptive, or healthy, stress coping mechanisms, one can efficiently return to normal levels of NE, E, and cortisol. Due to maladaptive, or negative, stress coping mechanisms, dysfunction results from elevated cortisol concentrations for prolonged periods of time

(Hannibal & Bishop, 2014). The consequences can result in an increased risk for depression, pain, and inflammation because of the high basal line of cortisol above normal circadian rhythmic levels (Austin et al., 2016; Engert, Efanov, Dedovic, Dagher, & Pruessner, 2011; Hannibal & Bishop, 2014; Holsboer, 2001).

Demanding academic loads and competitive environments that nursing students commonly experience are considered to be chronic stressors (Cha & Sok, 2014; Leodoro, 2013; Stark et al., 2005). This repetitive stress combined with poor stress coping habits can cause the over activation of the stress signaling pathways of the HPA axis. This puts the nursing student population at risk for stress-related health problems. These chronic stressful states can cause hyperactivity and hypersensitivity within the HPA axis leading to hypercortisolism (Hannibal & Bishop, 2014; Holsboer, 2001). Hypercortisolism can lead to a variety of physiological problems such as hypertension, hyperinsulinemia, hyperglycemia, insulin resistance, cardiovascular disease, hormone receptor desensitization, weakened immune function, and breakdown of muscle and bone tissues (Hadley & Levine, 2006; Hannibal & Bishop, 2014; Holsboer, 2001; Matousek et al., 2010; Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012; Thirthalli et al., 2013). Psychological conditions, such as anxiety, depression, panic attacks, and post-traumatic stress disorder (PTSD) are also linked to chronically elevated cortisol concentrations (Bayoumi et al., 2012; Hellhammer, Wüst, & Kudielka, 2009; Holsboer, 2001; Li & Goldsmith, 2012; Streeter et al., 2012; Yoshihara, Hiramoto, Oka, Kubo, & Sudo, 2014).

COMPLEXITY OF MEASURING CORTISOL

The difficulty of measuring stress-related disease and HPA axis dysfunction is partly due to the multiple roles of cortisol. Although a diurnal circadian rhythm orchestrates a predictive pattern of cortisol, there are several additional variables that can fluctuate cortisol levels above normal rhythmic oscillations. These include sample collection timing, perception of stress, history of traumatic stress, chronic exposure to stress, social support, social hierarchy, psychological interventions, personality factors, age, gender, menstrual cycle, pregnancy, calorie & caffeine intake, medications, smoking, drug consumption, fitness level, and exercise intensities (Hellhammer et al., 2009; Kudielka et al., 2009).

An objective way to measure cortisol is through one's saliva, urine, or blood serum (Hellhammer et al., 2009; Holsboer, 2001; Whitworth et al., 2005). The salivary sample collection method is the least invasive approach and an effective way to measure psycho-physiological stress levels in relation to exercise training, depression, anxiety, cardiovascular disease, and stress-related obesity (Anderson & Wideman, 2017; García-Sesnich et al., 2017; Gatti & De Palo, 2011; Hellhammer et al., 2009; Holsboer, 2001; Knorr, Vinberg, Kessing, & Wetterslev, 2010; Matousek et al., 2010; Thirthalli et al., 2013; Vicennati, Pasqui, Cavazza, Pagotto, & Pasquali, 2009).

Exercise is another form of stress and causes a production of cortisol via the HPA axis. Within the first few seconds of initiating physical activity (PA), NE and E are released via the SNS. Then minutes later, the secondary hormonal response of cortisol affects glucose, protein, and free fatty acid metabolism: (i) promotes catabolism of protein and triacylglycerols; (ii) supports the action of growth hormone (GH) and glucagon; (iii) serves as an insulin antagonist; and (iv) suppresses immune system function(Hadley & Levine, 2006; McArdle, Katch, & Katch, 2015).

The secretion or mitigation of cortisol concentrations are dependent on the fitness level of an individual along with the frequency, intensity, time, and type (FITT principles) of the PA performed (Clay, Lloyd, Walker, Sharp, & Pankey, 2005; Egan, Foster, & McGuigan, 2004; Gatti & De Palo, 2011; Helgadóttir, Hallgren, Ekblom, & Forsell, 2016; Hill et al., 2008; Scerbo, Faulkner, Taylor, & Thomas, 2010; VanBruggen, 2010). Cortisol adaptations from fitness training can enhance the elasticity of the HPA axis response to stress. These adaptations facilitate a quickened return to normal homeostatic balance and promote a greater potentiation threshold to lessen excessive neuroendocrine activation from minor stressors (Crewther, Cronin, Keogh, & Cook, 2008; Hill et al., 2008; Smilios, Theophilos, Karamouzis, & Tokmakidis, 2003; Thirthalli et al., 2013; Whitworth et al., 2005).

In general, if the aerobic or resistance exercise performed meets a moderate intensity PA threshold, a peak in cortisol concentration arrives about 15-30 minutes post-exercise intervention (Anderson & Wideman, 2017; Crewther et al., 2008; Hellhammer et al., 2009; Kudielka et al., 2009; Mathé, 2000; VanBruggen, 2010). This threshold will vary depending on the fitness level of an individual; the more fit the person the higher their threshold. Thus, well-trained individuals may require higher intensity exercise to get the same exercise-induced cortisol response when compared to someone less trained. By surpassing the moderate intensity PA threshold, heightened cortisol concentrations are predicted to occur post-exercise intervention. If the PA is does not cross the moderate intensity threshold, it is not likely that an influx of cortisol concentrations will occur after the exercise performed. Prolonged duration and high intensity PA creates elevated cortisol concentrations for extended periods of time (Scott et al., 2010; Whitworth et al., 2005). As a generalization, the more intense the PA the more likely cortisol concentrations will be elevated post-exercise.

The World Health Organization (2018) (WHO) recommends 150 minutes of moderate intensity activity per week to maintain cardiovascular health. Fitness training and maintenance may play a role in promoting homeostatic balance for the HPA axis and cortisol (Gatti & De Palo, 2011; Hill et al., 2008; Whitworth et al., 2005). The relationship between (i) fitness maintenance, (ii) the release of cortisol due to a moderate intensity exercise threshold and (iii) the FITT principles of an exercise intervention indicate that acute exercise stress and chronic exercise training have an effect on the production and regulation of cortisol.

The Sanskrit definition of *yoga* is the 'union or yoke' of the body, mind, and spirit. Yoga is a complex system that encompasses an intricate combination of (i) physical postures to promote strength and flexibility; (ii) breathing exercises to enhance respiratory functioning; (iii) deep relaxation techniques to reduce mental and physical tension; along with (iv) meditation and mindfulness practices to increase mind–body awareness and enhance emotion regulation skills (Butzer et al., 2015; Chugh-Gupta, Baldassarre, & Vrkljan, 2013). In general, a review study reported that 52 various styles of yoga produce an overall positive health outcome (Cramer, Lauche, Langhorst, & Dobos, 2016). But, there is limited data to decipher the specific psycho-physiolgocial variations between the numerous forms, styles, practices, and lineages of yoga (Cramer et al., 2016; Larson-Meyer, 2016; Pascoe & Bauer, 2015).

The *asanas*, or postures, practiced in a yoga session can reach intensities of light-moderate PA depending on the FITT principles of the *asanas* performed (Hagins, Moore, & Rundle, 2007; Larson-Meyer, 2016; Ray, Pathak, & Tomer, 2011). *Yoga Nidra* (yogic sleep), a practice that involves deep relaxation and meditation practices while lying in *savasana* (corpse pose) for 25-45 minutes, requires no physical exertion (Michael, 2017). On the other side of the spectrum, *asanas* (postures) and *pranayamas* (breath work practices), require energy and effort to accomplish. The energy expenditure and metabolic equivalents (METs) required to perform yoga depend on the FITT princples of the *asanas* and *pranayamas* implemented (Cowen & Adams, 2007; Hagins et al., 2007; Larson-Meyer, 2016; Potiaumpai, Martins, Rodriguez, Mooney, & Signorile, 2016;

Subedi, 2014). For example, Larson-Meyer (2016) reported a range of 1.4 – 4.0 METs between individual *asanas* and a range of 1.0 – 1.6 METs between individual *pranayama* practices.

A continuous flow of *asanas* are linked together via the breath and referred as a *vinyasa* practice. *Vinyasa* flows are also known as Sun Salutations or Moon Salutations. The Sun Salutation portion of a yoga practice expends more energy than the Non-Sun Salutation portion with 3.73 kcal/min and 3.01 kcal/min, respectively (Hagins et al., 2007). Furthermore, Sun Salutations cadanced at different speeds fluctuate in energy expenditure and muscular activation. Standard speed yoga (SSY) is defined as having 10-12 seconds in-between *asanas,* while high speed yoga (HSY) has 3-5 seconds in-between postures. Not only did the SSY average 3.30 kcal/min in comparison to the HSY of 5.42 kcal/min, but the HSY also produced a higher caridovascular output and increased muscular activation due to the swiftly cadanced speed (Potiaumpai et al., 2017, 2016).

Cortisol Response to Yoga Interventions

The structure and FITT principles of a yoga session are important factors to consider when comparing research outcomes. As previously mentioned, cortisol responds differently to various exercise protocols (Egan et al., 2004; Klentrou et al., 2016; Smilios et al., 2003; Whitworth et al., 2005), thus in theory, variable cortisol responses would result depending on the FITT principles of the yoga session performed. SSY showed to be a low-intensity PA, while HSY was classified as a moderate-high intensity PA

(Potiaumpai et al., 2016). Theoretically, the faster the speed of the yoga *vinyasas*, the higher the cortisol concentrations 15-30 minutes post physical intervention.

Contrary to the theory purposed above, evidence supports the decrease of cortisol levels from acute bouts of yoga, although consistent yoga practice may help to enhance the cortisol response to exercise. The reduction and regulation of cortisol levels are associated with a decrease in anxiety and depressive symptoms (Chugh-Gupta et al., 2013; Field, 2011, 2016; Field, Diego, Delgado, & Medina, 2013; Helgadóttir et al., 2016; Kamei et al., 2000; Li & Goldsmith, 2012; Papazisis et al., 2014; Pascoe & Bauer, 2015; Raub, 2002; Schuver & Lewis, 2016; Sheffield & Woods-Giscombé, 2016; Streeter et al., 2012; Telles, Pathak, Kumar, Mishra, & Balkrishna, 2015; Thirthalli et al., 2013). Yoga and the respective effects on cortisol regulation may serve the nursing student population whom suffers from depression, anxiety, and stress.

Theory of Yoga Class Design to Reduce Cortisol

Although many studies support that the acute and chronic practices of yoga promote healthy cortisol regulation, there is a lack of yoga science research that emphasize Eastern *Ayruvedic* philosophies. *Ayurveda*, or traditional Indian medicine, is commonly used for medicinal purposes. The reliability of *Ayruvedic* practices are still in their preliminary stages (Kurande, Waagepetersen, Toft, & Prasad, 2013).

The *Ayruvedic* practices within this study focus on the *gunas*, or energetic qualities of the mind. The three *gunas* of the mind are as follows: *sattva* (balance, equilibrium), *raja* (activity, transition), and *tama* (stability, heaviness). Theoretically, disease occurs when a g*una* falls out of balance. For example, if the quality of the *raja guna* is excessive, one expresses attitudes and emotions described as anger, anxiety, fear, and insecurity. Additionally, if the *tama guna* is excessive, ones expresses attitudes and emotions described as heaviness, depression, grief, hopelessness, loneliness, self-pity, and shame. Prolonged imbalanced states of the *tama* and *raja gunas* are postulated to produce high cortisol levels due to the hypersensitivity within SNS stress response and the HPA axis (Kraftsow, 1999).

Chronological yoga sequencing concepts of the *brahmana/langhana* strategy (BLS) by Kraftsow (1999) are hypothesized to reduce depression and anxiety. No peer-reviewed studies to the author's knowledge have approached treating a population with this type of *Ayruvedic* sequencing strategy. The overall purpose of the BLS is to create more of a balanced state within *raja* and *tama gunas* of the mind to promote health and reduce suffering.

Brahmana means to build up or expand, while *langhana* means to reduce and calm. The BLS initially increases PA through invigorating *asanas* to stimulate the SNS and is considered to be the *brahmana* portion of the yoga session. Then the *langhana* portion calms the body and mind via specific *asanas* (postures), *pranayama* (breath work), *savasana* (relaxation), and *dhyana* (meditation) to enhance the activation of the parasympathetic nervous system (PNS). Practices to induce *brahmana* qualities are designed to strengthen the body by moving it through *asanas* such as *vinyasa* flows, backbends, extensions, and laterals. Approaches to provoke *langhana* qualities are designed to bring balance and steadiness back into the body and mind. *Langhana* techniques require longer holds in restful *asanas* such as supported forward folds and supine twists; slowed *pranayama* with a focus on the exhales; and guided relaxation and meditation practices. The BLS's sequencing concepts are theoretically designed to reduce symptoms of depression and anxiety by bringing the physical body and *gunas* of the mind into balance and reducing the chronic firing of the HPA axis and other stress response systems (Kraftsow, 1999).

The Para Yoga Blueprint (PYB) of Mirsky (2016) inherently follows the chronological sequencing of the BLS. First, the PYB incorporates invigorating *asanas* that support the enhancement of *brahmana* qualities, then utilizes *asana*, *pranayama*, *savasana*, and *dhyana* techniques to enhance *langhana* effects. Reference Table 1.1 for the full match-up of these two sequencing concepts. By designing a yoga session around both the BLS and PYB, the practice is hypothesized to reduce symptoms of depression and anxiety.

Table 1.1 - *Brahmana/Langhana* Strategy & Para Yoga Blueprint Concept Match-Up	
Brahmana/Langhana Strategy (Kraftsow, 1999)	Para Yoga Blueprint (Mirsky, 2016)
Brahmana Inducing (to energize, build up)	Centering
	Warms Ups
	Vinyasa Flows
	Standing Poses
	Transition to Floor Poses
	***Inversions (N/A for this study)
	Back Bends
Langhana Inducing (to calm, reduce)	Twists
	Forward Bends
	Savasana
	Pranayama
	Meditation

Table 1.1 – *Brahmana/Langhana* Strategy and Para Yoga Blueprint Concept Match-up. This table depicts the chronological ordering of the concepts from the BLS and PYB respectively matched-up with each other. ***Inversions were removed from this study due to the novice population participating within this project.

The fusion of the BLS and PYB theoretically balances the *raja* and *tama gunas* of the mind, therefore potentially reducing the over activation of the HPA axis commonly exhibited in individuals suffering from depression and anxiety. Ultimately, the infusion of these specific yoga interventions (BLS and PYB) may serve as an effective stress management tool to acutely reduce the stress biomarker, cortisol, which could enhance the health and well-being of nursing students.

PURPOSE OF THE STUDY

Nursing students are our future healthcare professionals, if they develop healthy stress coping mechanisms in their academic careers, they can live healthier lives when they continue on into their professional careers. The primary purpose of this study was to assess acute salivary cortisol responses in female nursing students who participated in three yoga sessions set at different cadenced speeds or exercise intensities. A secondary study objective was to incorporate the specific BLS and PYB strategies into yoga sessions to explore their relationship to cortisol response. Yoga science research can benefit by examining the cortisol response to various yoga speeds. This research can help to discern which yoga practice is more effective in promoting healthy stress coping mechanisms within nursing students.

METHODS

SUBJECTS

Nursing students were recruited from a local university via e-mails, word-of-mouth, and campus-wide communication systems. Individuals were excluded from the study if they (i) were male, (ii) under 18 over 30 years of age, (iii) had practiced yoga within the past two months, (iv) had a BMI over 40, (v) consumed medication with glucocorticoids, cortisone, prednisolone, or dexamethasone within the past 3 months, or (vi) failed the Physical Activity Readiness Questionnaire (PAR-Q). This study was approved by the Institutional Review Board at Northern Michigan University (HS17-827). All subjects were informed about the potential risks associated to yoga and could leave the experiment at their own will. They were incentivized to complete the study's protocol by receiving a yoga mat and yoga class packages upon completion of the study. The class packages included (i) one free yoga pass for each subject, (ii) a second pass for a friend, and (iii) a drawing for a 5-pack of yoga classes at a local yoga studio within the community.

PROTOCOL

Subjects committed to an informational meeting and three yoga sessions over a five-week timeframe, all of which were held on campus to reduce barriers of transportation (Brems et al., 2015; Sheffield & Woods-Giscombé, 2016). The informational meeting included an explanation of the study, the salivary sample collection procedures, and demonstration of the different yoga speeds. Students were blind to the speed of yoga they were going to perform until they completed their first salivary sample on the day of each yoga session. The FITT principles that differed within the three yoga sessions were the (i) intensity of speed and (ii) frequency of postures performed. The three yoga sessions were not randomized and were practiced in the following order: the first yoga session consisted of a Standard-speed yoga (SSY) practice with about 10-12 seconds between *asanas*; the second yoga session consisted of a High-speed yoga (HSY) practice with about 3-5 seconds between *asanas*; and the third yoga session consisted of a Slow-speed yoga (SLSY) practice with about 60-120 seconds between *asanas.* The timeline is referenced in Figure 1.2. The cadence of both the HSY and SSY sessions were modeled from previous studies (Potiaumpai et al., 2017, 2016), while the SLSY session was structured similar to yin yoga (Grilley, 2007).

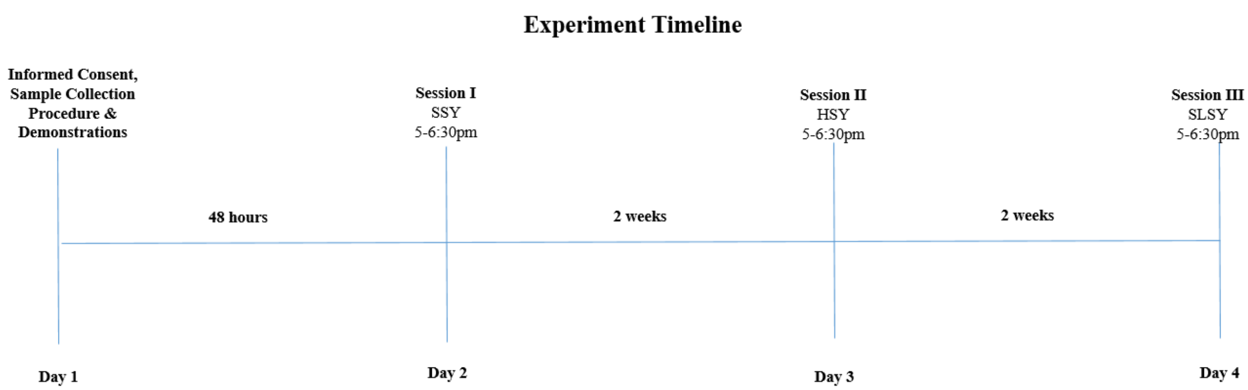

Figure 1.2 Overview of experimental timeline and schedule.

Each yoga session was facilitated by the same 500 hour registered yoga teacher (RYT) certified through the Yoga Alliance, an internationally recognized organization.

All *asanas* were modified for a novice or beginner population. For example, no *chaturanga dandasanas,* four-limbed staff poses, were performed within this study due to the complexity of the posture. Instead of *chaturanga dandasana*, a modified version of the posture was used known as *ashtanga namaskara,* or knees-chest-chin pose. Subjects were instructed to maintain the specific yoga session's cadence to the best of their abilities.

Design of Yoga Sessions

Each yoga session incorporated the abovementioned concepts of the BLS of Kraftsow (1999) and the PYB of Mirsky (2016) outlined in Table 1.1. The details of the class designs are listed within Tables 1.2 – 1.4. Each class design was cadenced at a different speed. The HSY was predicted to produce a larger cortisol concentration 15-30 minutes post yoga session because it would have a higher intensity than the other two speeds of yoga. Due to the faster cadenced speeds within the SSY and HSY yoga sessions, the frequency of postures performed were also anticipated to be higher in comparison to the SLSY. By provoking different exercise intensities, we were looking to find a difference in cortisol responses between the three yoga sessions. HSY is projected to surpass the moderate intensity exercise threshold to elicit an elevated cortisol response 15-30 minutes post yoga session because previous research supports that it is a moderate-high intensity exercise (Potiaumpai et al., 2016). Although SSY is considered a low-intensity exercise (Potiaumpai et al., 2016), the Sun Salutation portion of the yoga session was predicted to create a slightly elevated cortisol response 15-30 minutes post yoga intervention. However, SLSY session was expected to acutely decrease cortisol concentrations because it was not expected to cross the moderate intensity exercise threshold.

Table 1.2 - Standard-Speed Yoga (SSY) Session	
Cadenced with 10-12 seconds between postures	
Sun Salutations	
Para Yoga Blueprint (Mirsky, 2016)	
Time of Day: 5pm - 6:30pm	
Salivary Sample #1 - Minute 0	
Center	Seated 3-part diaphragmatic *pranayama*
Warm-ups	Modified dynamic *Bharadvajasana I* (L/R - 2x); Dynamic *parsva sukhasana* (L/R -2x); *Marjariasana* (4x); dynamic *adho mukha shvanasana* to hands & knees to *balasana* (4x total) with *Anjaneyasana* (L/R - 1x) and *Bhujangasana* (1x)
Vinyasa	*Surya Namaskara C* (4x - 1st two Salutes with *Anjaneyasana;* 2nd two Salutes with *Alanasana*)
Standing Postures	*Virabhadrasana I* static hold for 12 seconds (L/R - 1x); *Virabhadrasana I* with dynamic arm movements (L/R - 5x); *Utkatasana* static hold for 12 seconds (1x); *Utkatasana* with dynamic arm movements (5x)
Transition (to floor)	*Prasarita Padottanasana I* static hold for 12 seconds (1x); *malasana* static hold for 12 seconds (1x)
Inversions - N/A	***Novice Subjects - no inversions were introduced
Backbends	*Salabhasana* with dynamic arm movements (4x)
Twists	*Marichyasana* III static hold for 12 seconds (L/R - 1x)
Forward-Folds	*Janu Sirsasana* static hold for 10 seconds (L/R - 1x); *Ardha Ananda Balasana* static hold for 12 seconds (L/R - 1x); *Ananda Balasana* static hold for 12 seconds (2x)
Salivary Sample #2 - Minute 50	
Savasana	*Shavayatra* - 31 points - 14 minutes
Pranayama	1:2 ratio - long, slow, gentle exhales - 3 minutes
Meditation	*Kaya sthira* - 3 minutes
Salivary Sample #3 - Minute 70	
Salivary Sample #4 - Minute 85	

Table 1.3 - High-Speed Yoga (HSY) Session	
Cadenced with 3-5 seconds between postures	
Sun Salutations	
Para Yoga Blueprint (Mirsky, 2016)	
Time of Day: 5pm - 6:30pm	
Salivary Sample #1 - Minute 0	
Center	Seated 3-part diaphragmatic *pranayama*
Warm-ups	Modified dynamic *Bharadvajasana I* (L/R - 4x); Dynamic *parsva sukhasana* (L/R -4x); *Marjariasana* (4x); dynamic a*dho mukha shvanasana* to hands & knees to *balasana* (6x total) with *Anjaneyasana* (L/R - 2x) and *Bhujangasana* (2x)
Vinyasa	*Surya Namaskara C* (8x - 1st four Salutes with *Anjaneyasana;* 2nd four Salutes with *Alanasana*)
Standing Postures	*Virabhadrasana I* static hold for 5 seconds (L/R - 2x); *Virabhadrasana I* with dynamic arm movements (L/R - 10x); *Utkatasana* static hold for 5 seconds (1x); *Utkatasana* with dynamic arm movements (10x)
Transition (to floor)	*Prasarita Padottanasana I* static hold for 5 seconds (2x); *malasana* static hold for 5 seconds (2x)
Inversions - N/A	***Novice Subjects - no inversions were introduced
Backbends	*Salabhasana* with dynamic arm movements (8x)
Twists	*Marichyasana* III static hold for 5 seconds (L/R - 2x)
Forward-Folds	*Janu Sirsasana* static hold for 5 seconds (L/R - 2x); *Ardha Ananda Balasana* static hold for 5 seconds (L/R - 2x); *Ananda Balasana* static hold for 5 seconds (4x)
Salivary Sample #2 - Minute 50	
Savasana	*Shavayatra* - 31 points - 14 minutes
Pranayama	1:2 ratio - long, slow, gentle exhales - 3 minutes
Meditation	*Kaya sthira* - 3 minutes
Salivary Sample #3 - Minute 70	
Salivary Sample #4 - Minute 85	

Table 1.4 - Slow-Speed Yoga (SLSY) Session	
Cadenced with 60-120 seconds between postures	
No Sun Salutations	
Para Yoga Blueprint (Mirsky, 2016)	
Time of Day: 5pm - 6:30pm	
Salivary Sample #1 - Minute 0	
Center	Seated 3-part diaphragmatic *pranayama*
Warm-ups	*Bharadvajasana I* static hold for 60 seconds (L/R - 1x); *Parsva sukhasana* static hold for 60 seconds (L/R -1x); *Ardha Ananda Balasana* static hold for 60 seconds (L/R - 1x)
Vinyasa	*** No Sun Salutes were incorpoarted into this class design*** Gentle and slow movement on all fours into *balasana* to *adho mukha shvanasana* with static holds for 60 seconds in *balasana* (2x) & a*njaneyasana* (L/R- 1x)
Standing Postures	*Prasarita Padottanasana I* static hold for 90 seconds (1x)
Transition (to floor)	*Malasana* static hold for 60 seconds (1x)
Inversions - N/A	***Novice Subjects - no inversions were introduced
Backbends	*Salamba Bhujangasana* static hold for 90 seconds (1x)
Twists	*Marichyasana* III static hold for 120 seconds (L/R -1x)
Forward-Folds	*Upavistha Konasana* statis hold for 120 seconds (1x); *Ananda Balasana* static hold for 120 seconds (1x)
Salivary Sample #2 - Minute 50	
Savasana	*Shavayatra* - 31 points - 14 minutes
Pranayama	1:2 ratio - long, slow, gentle exhales - 3 minutes
Meditation	*Kaya sthira* - 3 minutes
Salivary Sample #3 - Minute 70	
Salivary Sample #4 - Minute 85	

Tables 1.2 -1.4: Each table outlines a class design with the respective speed of yoga. All three yoga sessions follow the BLS and PYB chronological sequencing concepts. Salivary cortisol samples were collected at 0, 50, 70, and 85 minutes within each of the three yoga sessions.

Health History & Questionnaires

Each subject completed a Physical Activity Readiness Questionnaire (PAR-Q), Health History Intake Form (HHIF), and Weekly Self-Reported Questionnaires (WSRQs) on the initial demonstration day. For simplicity purposes, the HHIF had the subjects self-report their weight, height, academic year, brief health history, along with a baseline average of their weekly physical activity minutes, stress loads, and stress management levels. The WSRQs, referenced in Appendix F, were structured for the subjects to report their average weekly PA minutes, stress loads, subjective stress management levels, and any medications/over-the-counter drugs/caffeine/nicotine/alcohol consumed since 5:00 am on the respective yoga session day. The minutes of PA data collected was in reference to the average weekly physical activity minutes performed over the seven days prior to the yoga session. The stress intake portion of the questionnaire was designed to have higher numbers represent a more negative effect; Stress Load Scale: (1 = Stress free, 10 = Overwhelmed with stress) and the Stress Management Level Scale: (1 = Perfect at managing stress, 10 = Do not know how to manage my stress at all).

Salivary Samples

To control for salivary sample variances, subjects were asked to avoid the following: (i) brushing their teeth within 45 minutes prior to sample collection; (ii) getting dental work 24 hours prior to sample collection; (iii) eating sugary/acidic foods or a major meal 60 minutes prior to collection; (iv) consuming caffeine, nicotine, prescription/over-the-counter medications within the prior 12 hours before collection, and (v) exercising vigorously 24 hours prior to sample collection.

To control for diurnal cortisol discrepancies, all yoga sessions (SSY, HSY, and SLSY) were conducted at 5:00pm-6:30pm on Thursday evenings. A total of twelve salivary cortisol samples were collected from each subject: four samples during each of the three yoga sessions. Samples were collected via salivettes (specific tubes with synthetic swabs) at four time-points: pre-*asana* (PREA) at 0 min, immediate post-*asana* (POA) at 50 min, immediate post-*savasana*/*pranayama*/*dhyana* (POSPD) at 70 min, and 15 minutes post-yoga session (POS-15) at 85 min. Subjects were instructed to lightly chew the salivette swab for 90 seconds to ensure saturation, then to return the swab into the Salivette tube without their hands to prevent contamination of the swab. Samples were immediately centrifuged within 5 minutes of collection and frozen at -80 degrees C until analysis.

Salivary cortisol concentrations were determined in triplicate with a Salimetrics Salivary Cortisol Enzyme Immunoassay Kit (State College, PA). The cortisol sensitivity of the kit was 0.007 μg/dL. The specific protocol provided within the Salimetrics ELISA kit was followed for analysis. Assay plates were read using a Turner Biosystems Modulus Microplate Reader. The intra and interassay coefficient of variance percentages (CV %) were 19.8 % and 14.3 % respectively. All cortisol concentrations were determined by interpolation using (MyAssays.com) data reduction software via a 4-parameter non-linear regression curve fit.

Statistical Analysis

Data analysis was performed using a computer based statistical software program (IBM SPSS version 25.0). Means, standard deviations and ranges were computed for the self-reported information of the subjects: age, height, weight, BMI, academic year, weekly PA minutes, stress loads, and stress management levels. A correlation matrix of all variables was run to help detect any significant covariates. No relevant correlations were found, nor were there any significant patterns justified to hold merit, thus covariates were not used in the statistical analysis. A multi-factorial repeated measures analysis of variance (reANOVA) was used to determine significant differences in salivary cortisol differences across four time-points within the three yoga sessions (SSY, HSY, and SLSY). Both the main effects (yoga speed; time-points) and interaction (yoga speed x time-points) were compared using the Bonferroni confidence interval adjustment. If Mauchly's Test of Sphericity was violated, the Greenhouse-Geisser correction was used. If the main effect or interactions were shown as significant, pairwise comparisons were used to determine where the significance was located. The significance level was set at $p < 0.05$.

RESULTS

The primary purpose of this study was to measure the acute salivary cortisol response from three different yoga speed protocols: SSY, HSY, and SLSY. Only nine of the ten subjects completed all three yoga sessions and provided all twelve salivary samples. Due to a suspected outlier, only eight subjects were used for statistical analysis.

The outlier was removed from analysis because their mean cortisol concentration for the PREA measurements within the SSY session was 1.05800 ± 0.0625 µg/dL; nearly three times higher than the normal evening (p.m.) salivary cortisol concentration range. Normal evening salivary cortisol concentrations for adult females (ages 21-30) range within 0.000 – 0.359 µg/dL (Aardal & Holm, 1995), while adolescent females (ages 12-18) range within 0.000 – 0.259 µg/dL (Salimetrics, 2014). Moreover, the outlier's respective mean cortisol concentrations at each of the four time-points were 5-10 times higher than the other subjects during the SSY session. See Figure 1.3 for individual salivary cortisol responses to the yoga sessions. It is difficult to discern as to why the aforementioned discrepancies were revealed from Subject #3 in the SSY session, but consequentially all of this subject's data was removed completely from the statistical analyses.

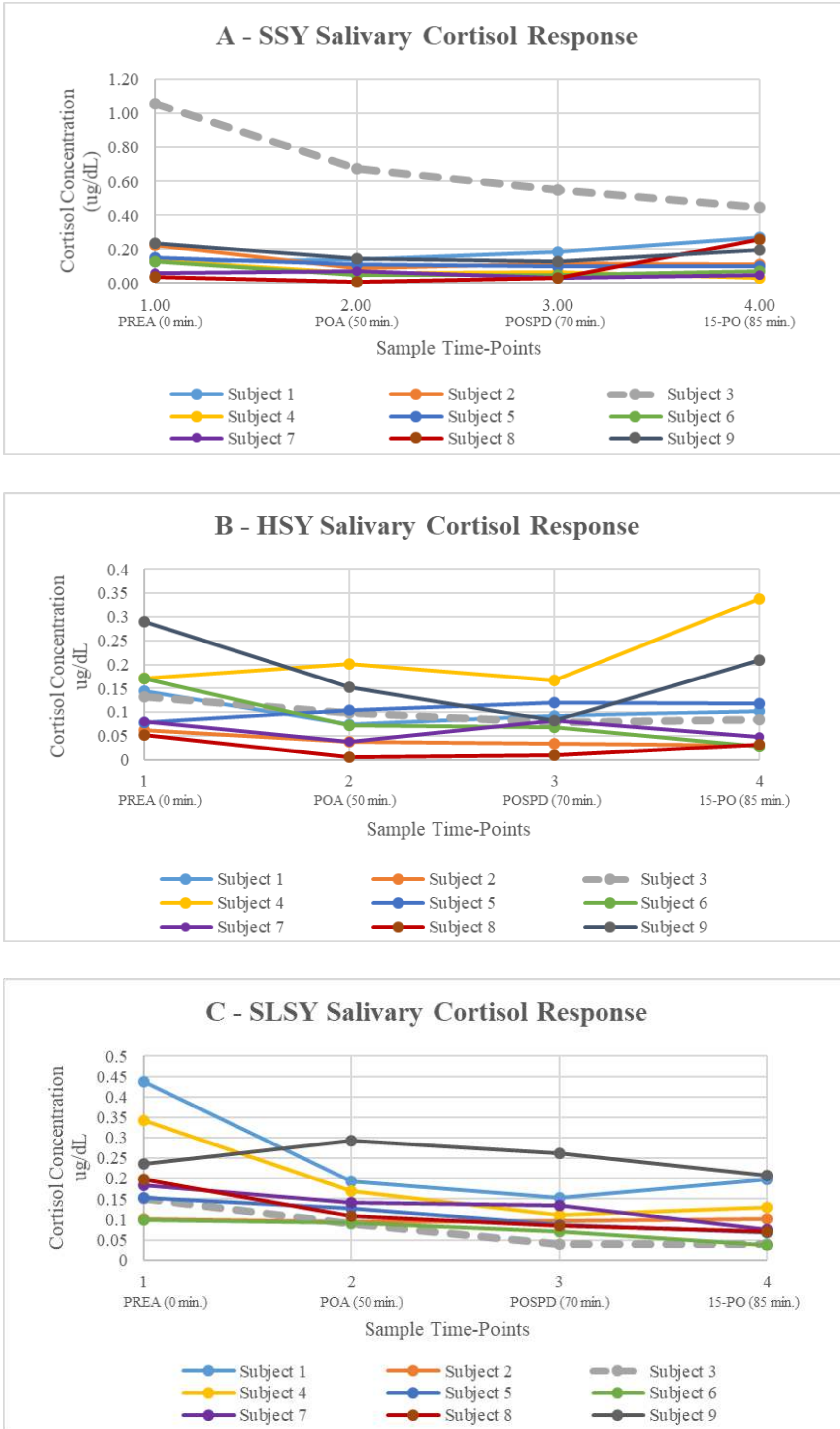

Figure 1.3 – Individual Salivary Cortisol Response for SSY, HSY, and SLSY. The figure depicts each of the nine subjects and their respective cortisol concentration at each of the four sample collection time-points across the three different speed intensities (SSY,

HSY, and SLSY). Time-points were defined as follows: PREA measurements were Time-point 1, POA measurements were Time-point2, POSPD measurements were Time-point 3, and 15-PO measurements were Time-point 4. This figure depicts how Subject 3 had 5-10 times higher cortisol concentrations for the PREA measurement within the SSY session, holding merit for their exclusion from statistical analysis.

General descriptive statistics of the subject's self-reported profile information (age, height, weight, BMI, and academic year) are provided in Table 1.5. The self-reported descriptive data (average weekly PA minutes, stress loads, and stress management levels) from the WSRQs are listed in Table 1.6.

Table 1.5 - General Subject Profile Information		
Variable	**Range**	**Mean ± SD**
Age (yrs.)	18 - 21	20.0 ± 1.2
Weight (lbs.)	115 - 185	144.8 ± 27.1
Height (in.)	62 - 71	65.6 ± 2.7
BMI (kg/m^2)	19.7 - 29.9	23.5 ± 3.5
Academic Year	**N = 8**	**Percentage**
1st	3	37.5%
2nd	0	0.0%
3rd	2	25.0%
4th	3	37.5%

Table 1.5: General Subject Profile Information – This table expresses descriptive data self-reported by the eight subjects (n = 8) used for statistical analysis. The respective

range, mean and standard deviation for each the following variables are displayed: age, weight (pounds), height (inches), Body Mass Index (BMI) and academic year.

Table 1.6 - Weekly Self-Reported Questionnaire Information		
Weekly Physical Activity (Min)	**Range**	**Mean ± SD**
Baseline	100-300	163.8 ± 71.7
SSY	60-200	133.8 ± 53.2
HSY	30-300	130 ± 87.0
SLSY	60-300	127.5 ± 78.1
Stress Load (Scale 1-10)	**Range**	**Mean ± SD**
Baseline	3-8	6.4 ± 1.8
SSY	5-9	7.1 ± 1.2
HSY	4-10	6.5 ± 1.9
SLSY	5-9	6.6 ± 1.6
Stress Management (Scale 1-10)	**Range**	**Mean ± SD**
Baseline	2-7	5.1 ± 1.7
SSY	3-7	5.5 ± 1.2
HSY	5-7	5.6 ± 0.7
SLSY	4-8	5.3 ± 1.3

Table 1.6 – Weekly Self-Reported Questionnaire (WSRQ) Information - This table expresses the range, mean and standard deviation values for the eight subject's (n = 8) weekly PA minutes, stress loads, and stress management levels at the baseline meeting, as well as, the SSY, HSY, and SLSY sessions. The questionnaire was designed to have higher numbers represent a more negative effect. Stress Load Scale: (1 = Stress free, 10 =

Overwhelmed with stress) Stress Management Level Scale: (1 = Perfect at managing stress, 10 = Do not know how to manage my stress at all).

The mean cortisol concentration and standard deviations were calculated for each time-point within each of the three yoga sessions. Standard Speed Yoga session measurements were PREA (0.14 ± 0.07), POA (0.08 ± 0.05 µg/dL), POSPD (0.09 ± 0.05 µg/dL), and 15-PO (0.14 ± 0.09 µg/dL). High Speed Yoga session measurements were PREA (0.14 ± 0.09 µg/dL), POA (0.09 ± 0.07 µg/dL), POSPD (0.08 ± 0.05 µg/dL), and 15-PO (0.11 ± 0.11 µg/dL). Slow Speed Yoga session measurements were PREA (0.22 ± 0.12 µg/dL), POA (0.15 ± 0.07 µg/dL), POSPD (0.13 ± 0.06 µg/dL), and 15-PO (0.11 ± 0.06 µg/dL). The results of the cortisol concentration response to all three yoga sessions are displayed in Figure 1.4. For the main effect across yoga speeds, Mauchly's Sphericity was assumed and no significant differences were found ($p = 0.094$). Greenhouse-Geisser correction was applied to the interaction between yoga speed and time-points and showed no significant differences ($p = 0.231$).

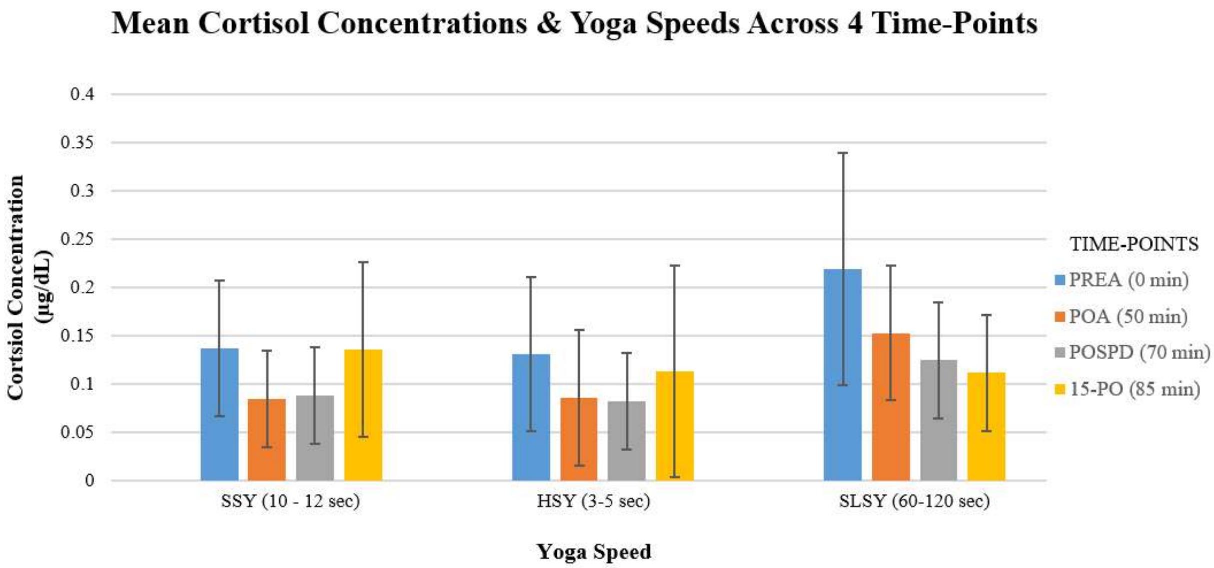

Figure 1.4 – Mean Yoga Speed & Cortisol Concentrations across Four Time-Points. This figure displays SSY, HSY, and SLSY sessions and the mean cortisol concentrations of the eight subjects at each of the 4 time-points. Error bars represent standard deviations of the mean cortisol concentrations. No significant differences were found across the main effect of yoga speeds ($p = 0.094$) or for the interaction between yoga speeds and the 4 time-points ($p = 0.231$).

Mauchly's test of Sphericity was assumed and there was a significant difference for the main effect across the 4 time-points ($p < 0.0001$). Using pairwise comparison, the mean cortisol concentration of the PREA measurements were significantly higher than all three of respectively combined post-measurements: POA with a mean reduction of 0.055 µg/dL ($p = 0.004$), POSPD with a mean reduction of 0.064 µg/dL ($p = 0.004$), and 15-PO with a mean reduction 0.042 µg/dL ($p = 0.040$). Additionally, there were no significant differences between the three post time-point measurements compared to each other ($p > 0.05$).

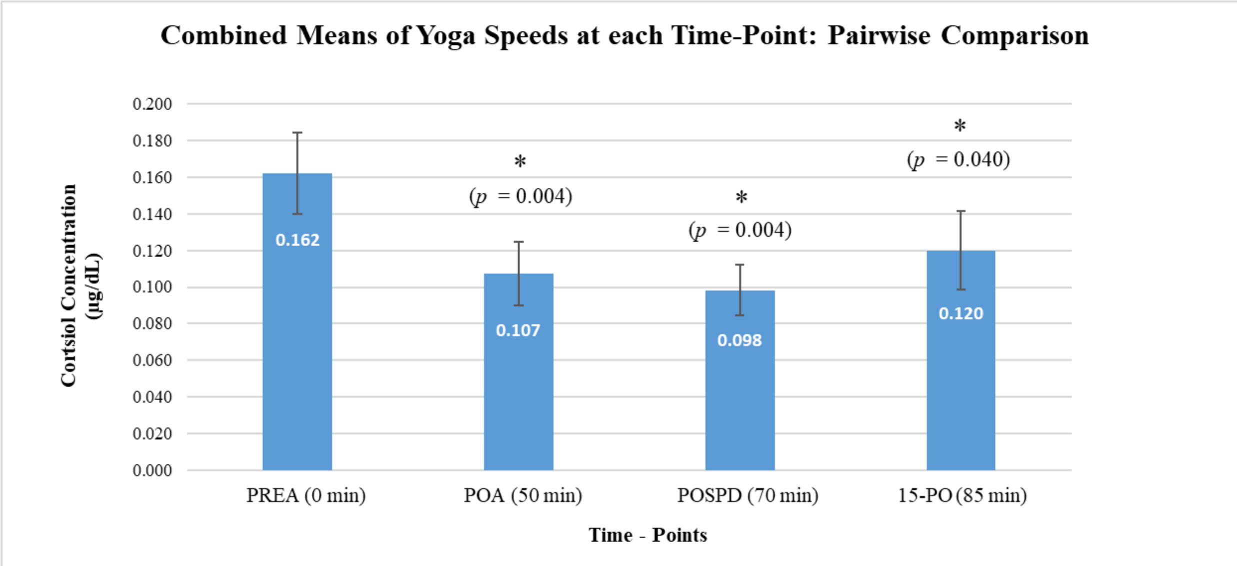

Figure 1.5: Combined Means of Yoga Speeds at each Time-Point: Pairwise Comparison - The significant difference of the main effect across all 4 time-points was $p < 0.0001$. The asterisks (*) within this figure express significant *p* values from a pairwise comparison of the combined averaged PREA measurements to the three combined averages of the post-measurements; POA ($p = 0.0040$), POSPD ($p = 0.0040$) and 15-PO ($p = 0.040$). There were no significant differences between the latter three of the four time-points ($p > 0.05$)

Overall, acute cortisol responses were not significantly different between the three yoga speeds and their respective time-point interactions, nor was there a significant difference within the main effect across the yoga speeds. With the three yoga sessions collapsed together, the main effect across the 4 time-points were significantly different ($p < 0.001$). Via pairwise comparison, significant decreases in cortisol were found between the pre-measurement (PREA) to all three post-measurements (POA, POSPD, and 15-PO), but the three post measurements were not significantly different from each other.

DISCUSSION

In this study, the salivary cortisol response in female nursing students was assessed across 4 time-points within three sessions of yoga cadenced at different speed intensities. Each of these three yoga sessions also incorporated *Ayruvedic* sequence design concepts of the BLS and PYB. The primary purpose of this study was to evaluate different salivary cortisol responses from the SSY, HSY, and SLSY speed intensities. The secondary purpose of this study was to explore the relationship of the chronological sequencing concepts of the BLS and PYB with their effects on salivary cortisol response.

The majority of the subjects (5 of 8) were enrolled in their third or fourth academic years and no students were in their second academic year. Previous research from (Papazisis et al., 2014) reported that nursing students experience less anxiety and depression in their third and fourth academic years. Never-the-less, the stress loads and stress management levels collected from the WSRQs, showed average stress loads of 6.7 (out of 10) and their ability to manage their stress loads averaged 5.4 (out of 10). This data is supported by similar findings from (Papazisis et al., 2014) in that 76% of nursing students reported to experience stress.

Furthermore, the salivary cortisol PREA (pre-*asana*) measurements taken prior to each of the three yoga sessions were equivalent to other young adult stressed populations (Austin et al., 2016; Engert et al., 2011). Research from Austin et al. (2016) revealed that females (mean age 25 yrs.) have 6 p.m. salivary cortisol measurements of between 4-5 nmol/L, which equates to about 0.15 – 0.18 μg/dL. Additionally, research from Abraham, Rubino, Sinaii, Ramsey, & Nieman (2013) suggests salivary cortisol measurements above 0.17 µg/dL are considered to be abnormal. Our current study found that the average of the combined PREA measurements, expressed in Figure 1.5, were measured at 0.162 µg/dL with a standard error (SE) of 0.022, suggesting that our sample of students were metabolically normal and within the normal evening (5:00 p.m.) cortisol range for their age.

Although an average BMI of 23.5 was calculated for the subject group, the BMI measurements ranged from normal to overweight. The stressed nursing students whom are classified as overweight could potentially be at a higher risk for elevated cortisol concentrations. This is supported by research from Vicennati et al. (2009) stating that stress-related obesity has distinct pathophysiological mechanisms, including hyperactivity of the HPA axis.

In general, yoga *asana* practices are classified as a light-moderate intensity exercise (Hagins et al., 2007; Larson-Meyer, 2016) and in some cases could help to fulfill the World Health Organization (2018) recommendation of 150 minutes per week of moderate aerobic intensity activities to maintain cardiovascular fitness. Moderate intensity activities are classified as at least three to six metabolic equivalents (3 - 6 METs) (World Health Organization, 2018). Fitness levels have an effect on the exercise-induced cortisol threshold. The more fit the subject, the higher their moderate intensity aerobic threshold, which could delay the exercise-induced cortisol response due to training adaptations. Previous fitness training can elicit different salivary hormone responses to various intensities of exercise-induced stressors (Anderson & Wideman, 2017; Gatti & De Palo, 2011). The current study attempted to control for previous yoga experience and collected the subject's average weekly PA minutes, but fitness levels were not measured. Due to the large range in self-reported weekly PA minutes reported (30-300 min per week), it is likely that the subjects had different athletic and fitness abilities.

Additionally, with fitness levels unknown, it was difficult to discern whether or not an intensity threshold was met to create an increase in salivary cortisol concentrations (Hill et al., 2008; Klentrou et al., 2016; Mathé, 2000; VanBruggen, 2010). When more sun salutations are performed at faster rates, the individual will expend more energy (Hagins et al., 2007; Potiaumpai et al., 2017, 2016), but varying fitness levels make it difficult to discern whether or not different yoga speeds surpassed the PA intensity threshold. Future research is recommended to measure individual energy expenditure, via portable gas analysis, during each yoga session to identify and control for intensity thresholds in order to understand the exercise-induced cortisol response.

The current study hypothesized that the more energy intensive yoga sessions (HSY and SSY) would have caused higher salivary cortisol responses 15-30 minutes post exercise. But contrary to the purposed theory, the results of this study revealed no yoga speed was more effective in reducing cortisol levels than another speed. Although our comparisons of cortisol response among the yoga speeds were not significant, replicating this study with a large sample may find different outcomes. Our data rejects our hypothesis in that the sun salutation portions within the SSY and HSY sessions did not reach a moderate intensity threshold and did not elicit an increase in salivary cortisol response 15-30 minutes post exercise intervention. Instead, this study supports that all speeds of yoga (standard, high, and slow) produce significant decreases in cortisol.

The secondary goal of this research was to explore the relationship of the salivary cortisol response to yoga sessions infused sequencing concepts the BLS and PYB. The purpose of these two energetic sequencing concepts was to decrease suffering of depression and anxiety by bringing the physical body into balance with the qualities of the mind. Although all yoga sessions were infused with the BLS and PYB, the significant reduction in cortisol concentrations cannot be solely attributed to these sequencing concepts. More research is needed to control for the BLS and PYB to identify their specific effects on the HPA axis.

Overall, the results of this study coincide with other research in that one single session of yoga can acutely reduce cortisol levels (Benvenutti et al., 2017; Kamei et al., 2000; West, Otte, Geher, Johnson, & Mohr, 2004). This study supports that an acute yoga session cadenced at a standard, high, or slow speed significantly reduced salivary cortisol concentrations within female nursing students. Furthermore, the researchers in the current study explored the sequencing concepts of the BLS and PYB which suggests their integration into the yoga session may have additionally contributed to the reduction in cortisol levels. Finally, this research indicated that the mind-body exercise of yoga has an ameliorative effect on the neuroendocrine mechanisms of the HPA axis for the stress biomarker, cortisol. No speed of yoga was more effective than another, thus all speeds of yoga may serve as an effective means to reduce the stress biomarker, cortisol, within nursing students. The reduction and regulation of cortisol through yoga can serve as a healthy stress management tool that could prevent chronic stress-related diseases, such as depression and anxiety, within nursing students.

LIMITATIONS & FUTURE RECOMMENDATIONS

This study has multiple limitations due to (i) the small sample group; (ii) the lack of a control group, (iii) the elevated intra-assay covariance measurements (CV%); (iv) the validity and reliability of the WSRQs for stress loads and stress management levels; (v) the multitude of individual differences between the subjects; and (vi) the absence of an objective measurement to properly assess the effectiveness of the BLS and PYB energetic concepts. Future recommendations are listed with their corresponding limitation.

By only having 8 subjects, the outcomes of this study do not hold enough merit that can be generalized to the entire nursing student population. However, the class sequences and designs laid out in this study could easily be replicated with a larger sample size to increase the validity and reliability of the findings. Future research, with a larger sample population, may further support the incorporation of yoga interventions into the nursing curriculum to help mitigate the excessive stress the students endure.

Another limitation was the lack of a true control to compare with the yoga intervention. Examples of controlled interventions that could be used in future research are walking, basic stretching, or seated while listening to a lecture.

Although the inter-assay coefficient of variance (CV %) of 14.3% was within an acceptable range of being below 15%, the intra-assay CV% of 19.8% is higher than some find acceptable; > 10% (Salimetrics, n.d.). Due to funding resources, this study was limited to having the graduate student running the ELISA kit in-house and resulted in a high margin of variability, despite finding significant results. Future studies could have the salivary samples professionally analyzed to reduce the amount of discrepancies within the inter & intra-assay CV% measurements.

This study did not measure the change in stress loads or stress management levels in response to the yoga intervention. To properly assess changes in stress, future studies could incorporate the use of questionnaires before and after each yoga session. Additionally, the WSRQs may have been too vague in regard to the measurements of the subject's stress loads and stress management levels. Further research may want to consider utilizing an established stress questionnaire for more reliable and consistent results for self-reported stress-related data.

Cortisol is influenced by many variables on an individual basis. Although we attempted to control for as many of these variables as possible, we did not control for all. Four of these variables may have affected the cortisol levels within this study and are worthy to mention. First, our volunteers were not evenly dispersed in their academic careers. As mentioned above, nursing students in their third and fourth academic years were reported to have less stress and depressive symptoms (Papazisis et al., 2014). Second, food intake has an effect on salivary cortisol (Hellhammer et al., 2009; Kudielka et al., 2009). Although we asked subjects to refrain from eating a major meal 60 minutes prior to the yoga sessions, we did not objectively measure their food intake. Third, an individual's moderate intensity threshold is dependent on his or her fitness level (Anderson & Wideman, 2017; Gatti & De Palo, 2011). Since we only accounted for the average amount of weekly PA minutes per subject, we were not able to clearly identify their fitness levels. Fourth, the lack of randomization within this study could have caused an order effect and/or a learning effect. Subjects may have experienced a progressive learning effect due to the order of the three yoga sessions and repetition of techniques within this study. In addition to performing many of the same physical postures, the guided practice of *Shavayatra* (31 points relaxation exercise) (Rama & Keshaviah, 2013), *pranayama* breath work with longer exhales (1:2), and *Kya Sthira* practices were repeated for all three sessions. These progressive learning effects may have caused variances within the psycho-physiological reactions to the three yoga sessions. The vast array of individualistic factors that play a role in cortisol and the stress signaling pathways are difficult to control, yet should be considered in future research.

Furthermore, the absence of an objective measurement to assess the effectiveness of the BLS and PYB sequencing concepts creates difficulty in understanding their success. While the significant reductions in cortisol levels cannot be fully accredited to these sequencing concepts, the class designs are a good tool for future research to replicate. The aforementioned goal of the BLS from Kraftsow (1999) is to create balance within the physical body and the *gunas* (energetic qualities) of the mind. Future research may want to consider utilizing an Ayruvedic questionnaire before and after yoga interventions to assess the subjective changes within the *gunas* of the mind. Moreover, further research should use specific *Ayruvedic* questionnaires to quantify the state of each of the three *gunas* (*sattva*, *raja*, and *tama)* within each subject. These questionnaires could help to assess the BLS and PYB sequence concepts and their respective effect on cortisol response.

Again, controlling for all of the variables associated with cortisol are challenging, but additional yoga research will benefit the Eastern and Western science fields by strengthening the reliability and validity of yoga as a stress reduction tool for nursing students and other health professionals.

SIGNIFICANCE OF STUDY

The main significant finding resulting from this study showcased acute 70-minute sessions of yoga, consisting of a 50-minute *asana* practice followed by 20 minutes of *savasana*, *pranayama*, and *dhyana*, completed at three cadenced speeds (standard, high, and slow), all significantly reduced the stress biomarker, cortisol. This provides evidence that yoga sessions practiced at various intensities produce similar effects within cortisol signaling pathways. Yoga effectively provided an acute way to mitigate cortisol within female nursing students.

This is the first study to introduce energetic sequencing concepts of the BLS of Kraftsow (1999) via the PYB of Mirsky (2016). This study promotes the need for additional yoga science research to investigate Eastern *Ayruvedic* philosophies of yoga sequencing and the impact on stress hormone regulation.

CHAPTER II – REVIEW OF LITERATURE

STRESS & NURSING STUDENTS

Stress: Basic Overview

Stress can provoke both positive and negative psycho-physiological outcomes. Eustress is beneficial stress and is associated with positive feelings and healthy bodily states, like the type of stress provoked with acute moderate exercise. Distress is harmful stress and is associated with negative feelings and disturbed bodily states (Lazarus, 1993), such as the type of stress associated with inflammation and disease (Hannibal & Bishop, 2014). Stress is a response caused by a physical or psychosomatic event that results in homeostatic imbalance (Holsboer, 2001). Stressors, or events that alter one's internal equilibrium, originate in many forms: biological, environmental, social, emotional, and psychological (García-Sesnich et al., 2017).

Stress in Nursing Students

Nursing students commonly experience stress more often than other academic majors (Stecker, 2004). Papazisis et al. (2014) reported that 76.4% of nursing students suffer from stress, ranging from mild to severe. Throughout the process of becoming a health care professional, nursing students often do not dedicate time for their own self-care and stress management practices (Stark et al., 2005). Extensive schedules, rigorous academic loads, and highly competitive environments are stressful demands placed on nursing students. Additionally, they experience real-world situations of hardship, enraged emotions, and difficult situations with patients and families (Cha & Sok, 2014).

In research from Lund et al. (2010), general college students reported to have bedtimes and rise-times delayed during weekends, to use prescription and recreational drugs to alter their sleep/wakefulness states, and to be poor-quality sleepers. In addition to poor sleep hygiene within college students, conditions such as depression, anxiety, and substance abuse are highly prevalent among nursing students (Bayoumi et al., 2012; Leodoro, 2013; Stecker, 2004).

The lowest levels of depression were observed in the third and fourth study years of the curriculum (Papazisis et al., 2014), which could be due to their ability to adapt and adjust to the academic and clinical requirements. As they progress through the program, nursing students are likely to have gained experience of the professional skills required for real-life settings. Moreover, nursing students in their third and fourth years of their curriculum may have efficient and effective ways in dealing with stress (Leodoro, 2013). In general, 62% of the nursing students reported to have mild to severe symptoms of depression (Papazisis et al., 2014) and 53% of nursing students reported to have mild to moderate anxiety (Bayoumi et al., 2012). The chronic exposure to stressors and the high prevalence of stress-related disease are concerning for this at-risk population.

Coping strategies lessen the effect of stress and will affect one's degree of resiliency and adaptability (Sherrer, 2011). Long term resilience is produced when an individual practices active coping skills; dealing with challenges, facing fears, participating in problem solving, and engaging in optimism. A short term and maladaptive solution to managing stress is through passive coping mechanisms; feelings of denial, avoiding conflict, and suppressing emotions (Franklin, Saab, & Mansuy, 2012; Sherrer, 2011). Although nursing students may increase self-care and stress management practices if they were given the time, maladaptive coping mechanisms repeatedly become their solution to the demanding stress loads of their academic careers (Stark et al., 2005). Common harmful coping mechanisms practiced by nursing students are drinking alcohol (80%), using illegal drugs (19%) (Stecker, 2004), and smoking tobacco (18%) (Fernández et al., 2015).

The alarming statistics presented above reiterate the high prevalence of stress, anxiety, and depression within nursing students and calls for healthy and effective stress management interventions. Nursing students, our future healthcare professionals, hold an inherent responsibility to make healthy choices and lead by example. By developing healthy stress coping habits, nursing students would be able to enhance their own health and well-being and to teach their future patients from personal experience (Stark et al., 2005).

Cortisol: A Basic Overview

Cortisol is a metabolic regulation hormone. This complex glucocorticoid hormone that is regulated by the hypothalamic pituitary adrenal (HPA) axis through a negative feedback loop pattern. It is also a major contributor to mammalian circadian rhythms and plays a vital role in the psycho-physiological stress responses (Hannibal & Bishop, 2014b; Hellhammer et al., 2009; Holsboer, 2001; McArdle et al., 2015).

Circadian Rhythm

The production and release of cortisol are dependent on the time of day and vary considerably throughout a 24-hour time period (Li & Goldsmith, 2012). No other molecule within mammalian organisms is secreted in such a wide concentration range (Holsboer, 2001). A normal diurnal rhythm has a cortisol awakening response (CAR), or peak in cortisol concentration, within 20-60 minutes after awakening. The CAR measurements are 50-160% higher than cortisol levels in the evening (Anderson & Wideman, 2017; Clow et al., 2004). By mid-afternoon these concentrations have been reduced by half, continue to lower throughout the evening, and finally the lowest by midnight (Hackney, 2010; Matousek et al., 2010).

Hypothalamic Pituitary Adrenal (HPA) Axis

The HPA axis regulates the production and release of the hormone cortisol. This neuroendocrine axis is affected by the limbic system (Hellhammer et al., 2009; Thirthalli et al., 2013) and is deeply embedded as a secondary response to the evolutionary survival mechanism of the fight-or-flight response within the sympathetic nervous system (SNS) (Kudielka et al., 2009). The autonomic nervous system (ANS) within the brain determines what is stressful and initiates a response within the HPA axis, limbic system, and other stress signaling pathways (Thirthalli et al., 2013).

In a healthy adult, various stress-related stimuli cause the paraventricular nucleus (PVN) of the hypothalamus to synthesize corticotrophin-releasing hormone (CRH). Via portal circulation, CRH stimulates the synthesis and release of adrenocorticotropic hormone (ACTH) from the anterior pituitary gland. The release of ACTH into the bloodstream travels to the adrenal glands just above the kidneys. Receptors within the adrenal cortex bind to ACTH and enable the release of cortisol into the bloodstream (Holsboer, 2001). Under normal homeostatic conditions, elevated concentrations of cortisol signal mitigation within the negative biofeedback loop once the stressor is removed (Holsboer, 2001; Whitworth et al., 2005).

HPA Axis: Dysfunction & Disease

Cortisol dysfunction and HPA axis overstimulation are caused by chronic exposure to stressors. The chronic stress response is different from an acute stress response and is summarized in the flow chart below in Figure 2.1 created by Hannibal & Bishop (2014).

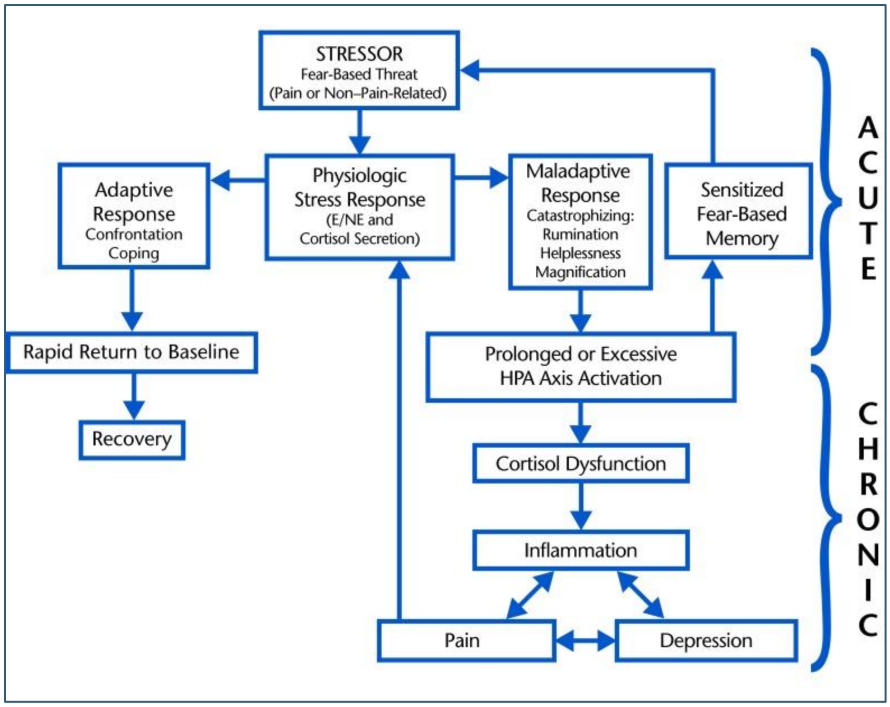

Figure 2.1 – Acute and Chronic Stress Reponses - This flow chart, created by Hannibal & Bishop (2014), displays the differences between acute (short-term SNS and hormonal activation/recovery) and chronic (cortisol dysfunction) stress responses. (Permission to use figure in Appendix G.)

Initially, the SNS causes the release of norepinephrine (NE) and epinephrine (E) followed by the secondary hormonal secretion of cortisol. With adaptive stress coping mechanisms, one can efficiently return to normal levels of NE, E, and cortisol. Chronic exposure to stress in combination with maladaptive stress coping mechanisms can cause cortisol dysfunction. This results in elevated cortisol concentrations for prolonged periods of time because the NE, E, and cortisol levels are unable to return back to homeostatic balance in an efficient manner (Hannibal & Bishop, 2014). The consequences are associated with an increased risk for depression, pain, and inflammation due to the high basal line of cortisol above normal circadian rhythmic levels (Austin et al., 2016; Engert et al., 2011; Hannibal & Bishop, 2014; Holsboer, 2001).

The repetitive stress nursing students experience combined with their poor stress coping habits can cause the over activation of the HPA axis. The risk for hypothalamic-induced hypercortisolism within the general population is on the rise (Whitworth et al., 2005). These chronic stressful states can cause hyperactivity and hypersensitivity within the HPA axis and can lead to hypercortisolism (Hannibal & Bishop, 2014; Holsboer, 2001).

Hypercortisolism can lead to a variety of physiological problems, such as hypertension, hyperinsulinemia, hyperglycemia, insulin resistance, cardiovascular disease, hormone receptor desensitization, weakened immune and reproductive funcion, and breakdown of muscle and bone tissues (Hadley & Levine, 2006; Hannibal & Bishop, 2014; Holsboer, 2001; Matousek et al., 2010; Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012; Thirthalli et al., 2013). Furthermore, cortisol increases fat mobilization, but if these fatty acids are not utilized, the substrate is stored as visceral adipose tissue contributing to increased truncal obesity (Whitworth et al., 2005).

Psychological conditions, such as anxiety, depression, panic attacks, and post-traumatic stress disorder (PSTD) are also linked to chronically elevated cortisol concentrations (Bayoumi et al., 2012; Hellhammer et al., 2009; Holsboer, 2001; Li & Goldsmith, 2012; Streeter et al., 2012; Yoshihara et al., 2014). These psychopathological diseases are developed from cortisol levels remaining high over the day and into the evening (Bayoumi et al., 2012; Gunnar & Vazquez, 2001; Hellhammer et al., 2009; Holsboer, 2001; Li & Goldsmith, 2012; Thirthalli et al., 2013; Yoshihara et al., 2014). Specifically, depression is associated with the lack of cortisol concentration variability throughout a 24-hour period (Gunnar & Vazquez, 2001). Research from Holsboer (2001), supports that hypercortisolism is not secondary to depression, rather it is the root cause of depression because of the neurological pathways being consistently triggered. Even minor stressors could stimulate the production of CHR in the amygdala, which is associated with anxiety, fear-based behaviors, and defensive reactions (Streeter et al., 2012). Understanding the underlying pathological mechanism relevant to HPA axis dysregulation is a key topic in psychobiological stress research (Kudielka et al., 2009).

Stress Biomarker: Cortisol

Although cortisol is a metabolic regulation hormone, it is commonly referred to as a stress biomarker in research (Gatti & De Palo, 2011; Hellhammer et al., 2009; Holsboer, 2001; Matousek et al., 2010; Whitworth et al., 2005). It is considered to be an effective and dependable way to measure physiological stress levels in relation to exercise training, depression, anxiety, cardiovascular disease, and stress-related obesity within human subjects (Anderson & Wideman, 2017; García-Sesnich et al., 2017; Gatti & De Palo, 2011; Hellhammer et al., 2009; Knorr et al., 2010; Matousek et al., 2010; Thirthalli et al., 2013; Vicennati et al., 2009).

Cortisol can be measured through salivary, serum, and urinary samples. About 95% of circulating plasma cortisol is bound tightly to corticosteroid-binding globulin (CBG) with a smaller portion loosely bound to albumin. The other 5% is free or unbound (Matousek et al., 2010). In most cases, researchers are measuring the free or unbound concentrations of cortisol. Salivary measures of free or unbound cortisol are considered a valid and reliable alternative to measuring free or unbound cortisol in serum (Matousek et al., 2010). Salivary samples are non-invasive and less anxiety provoking, thus holding its advantages in comparison to serum sampling (VanBruggen, 2010).

When measuring cortisol, circadian rhythm and post-intervention collection timing are crucial for accurate measurements. For example, when assessing longitudinal studies, researchers can assess the CAR or collect samples at multiple different time-points throughout a 24-hour period (Anderson & Wideman, 2017; Clow et al., 2004). For acute or short term studies, salivary cortisol concentrations peak at approximately 15 to 30 minutes after presented with a stressor (Kudielka et al., 2009). Commonly, researchers will collect cortisol samples prior to provoking acute stress, via exercise or a difficult task, then they collect measurements at 15-30 minutes post-stress intervention to assess the cortisol stress response (Mathé, 2000).

Precautions should be considered when measuring cortisol levels for stress-related psychobiological research (Crewther et al., 2008). Cortisol is not simplistic, nor does it function in isolation (Clow et al., 2004; Matousek et al., 2010). For accuracy and consistency, it is crucial for research designs to have proper collection and to control for variables that may influence cortisol. HPA axis activation and cortisol concentrations have been known to be affected by the following: circadian rhythm, sample collection timing, acute subjective-psychological stress responses, perception of stress, traumatic stress, chronic exposure to stress, social support, social hierarchy, psychological interventions, personality factors, age, gender, menstrual cycle, pregnancy, caloric & caffeine intake, smoking, drug consumption, and exercise intensities (Hellhammer et al., 2009; Kudielka et al., 2009).

EXERCISE-INDUCED CORTISOL RESPONSES

The HPA axis responds to an acute bout PA and chronic exercise-induced stress training, which will subsequently affect cortisol levels. Depending on the frequency, intensity, time, and type (FITT principles) of the acute bout PA performed, the cortisol can remain at elevated concentrations for up to 20 to 120 minutes after exercise-induced stress. Marathon running and high load resistance training are types of high intensity physical exercise that could extend the cortisol elevations post intervention (Ha, Baek, Kim, & Kim, 2015; Whitworth et al., 2005). Even though high intensity aerobic exercise has consistently demonstrated an acute increase in cortisol levels, resistance training has considerable variability depending upon study design (Hayes, Bickerstaff, & Baker, 2010). For example, a 145% increase in cortisol concentrations was found in high intensity versus low intensity resistance exercise sessions (Egan et al., 2004). In general, cortisol levels will increase as the following resistance exercise components increase: sets and repetitions performed, intensity, and metabolic requirements (Crewther et al., 2008; Jones, Howatson, Russell, & French, 2016; Smilios et al., 2003).

Consistent moderate exercise training creates a beneficial elasticity within the HPA axis (Anderson & Wideman, 2017; Batista, Souza, Ferreira, Canova, & Grassi-Kassisse, 2015). The threshold that initiates the exercise-induced stress response becomes more resilient to higher loads of stress. This favorable cortisol response can be measured through a couple of methods. The researcher could follow the cortisol changes that occur from acute exercise bouts and chronic exercise training. This could simply be done by taking pre and post exercise cortisol measurements and then follow this response over weeks of training. This would help the researcher understand how the individual acutely responds to the exercise each day and the response to training after a prolonged period of time. Another way to capture HPA axis adaptations in response to chronic exercise training is through the assessment of CAR and normal daily diurnal patterns. The peak in cortisol 20-60 minutes after awakening is higher in trained individuals in comparison to untrained individuals. Additionally, trained individuals have lower cortisol levels in the evening hours, suggesting that exercise training helps to regulate the wide concentration ranges of cortisol (Batista et al., 2015).

SURPASSING THE MODERATE THRESHOLD

The necessity of an exercise intensity threshold for hormonal release is not unheard of in exercise endocrinology literature (Hill et al., 2008). Studies suggest that a moderate intensity exercise threshold is needed to create an increase in cortisol levels 15-30 minutes after an exercise intervention (Anderson & Wideman, 2017; Crewther et al., 2008). VanBruggen (2010) suggests that approximately 60% of maximal aerobic capacity must be reached in order for cortisol levels to rise 15-30 minutes post exercise. Lower intensities may not provoke a response, thus not eliciting an acute increase of cortisol because the exercise threshold was not reached or surpassed. For example, low intensity exercise (40% $VO_{2\,max}$) did not result in significant increases in cortisol levels. Instead, a reduction in cortisol concentrations was observed (Hill et al., 2008).

Obtaining 150 minutes of moderate intensity physical activity is suggested by the World Health Organization (2018) help to maintain cardiovascular health and prevent chronic disease. Exercise effectively reduces tobacco cravings, treats mild depression, and helps to regulate the HPA axis function to support homeostatic balance (Anderson & Wideman, 2017; Helgadóttir et al., 2016; Scerbo et al., 2010; Telles et al., 2015). Helgadóttir et al. (2016) reported that low, moderate, and vigorous intensity exercises were all effective in treating mild to moderate depression. This suggests that a regular PA routine helps to enhance the elasticity of the HPA axis and cortisol response from exercise-induced stress (Anderson & Wideman, 2017; Telles et al., 2015).

YOGA: A BRIEF OVERVIEW

The Hatha Yoga Pradīpikā is a traditional fifteenth-century Sanskrit text written by Svāmi Svātmārāma, stating that *yoga* is the 'union or yoke' of the body, mind, and spirit. Patanjali's Traditional '8 Limbs of Yoga' consist of multifaceted components: (1) *yamas* (moral code), (2) *niyamas* (personal conduct), (3) *asana* (postures), (4) *pranayama* (breath work), (5) *pratyahara* (sense withdrawal), (6) *dharana* (focus), (7) *dhyana* (meditation), and (8) *samadhi* (union, absorption). Yoga is a complex and holistic system that encompasses (i) physical postures to promote strength and flexibility; (ii) breathing exercises to enhance respiratory functioning; (iii) deep relaxation techniques to reduce mental and physical tension; along with (iv) meditation and mindfulness practices to increase mind–body awareness and enhance emotion regulation skills (Butzer et al., 2015; Chugh-Gupta et al., 2013).

There is a vast assortment of yoga styles forms, types, and lineages. In general, the results from a yoga practice are beneficial. Out of 306 peer-reviewed articles there were 52 styles of yoga identified, all of which provided some sort of advantageous result (Cramer et al., 2016). Practicing yoga is known to effect individuals on a physical, mental, emotional, and spiritual level. Various benefits of yoga include, but are not limited to the following: increases in flexibility, balance, muscular strength, total muscle torque (Buśko & Rychlik, 2006); improves pain, stress, anger, relationships, gestational age at birth, birth weight, maternal–infant attachment, power, optimism, and well-being (Sheffield & Woods-Giscombé, 2016); enhances sleep and stress patterns (Vera et al., 2009); improves ability to cope with stress, self-esteem and perceived emotional well-being (Meissner, Cantell, Steiner, & Sanchez, 2016; Papazisis et al., 2014); reduces examination stress (Gopal, Mondal, Gandhi, Arora, & Bhattacharjee, 2011); and supports weight management (Hopkins et al., 2016). Most importantly for the purposes of this literature review, yoga helps to reduce symptoms of anxiety, depression, and postpartum depression (Chugh-Gupta et al., 2013; Field, 2011, 2016; Field et al., 2013; Helgadóttir et al., 2016; Kamei et al., 2000; Li & Goldsmith, 2012; Papazisis et al., 2014; Pascoe & Bauer, 2015; Schuver & Lewis, 2016; Sheffield & Woods-Giscombé, 2016; Telles et al., 2015).

Defining Yoga Intensity: Gap in the Research

In the westernized culture, the term 'yoga' is commonly misconstrued as postural yoga, which can be misleading to the novice practitioner (Markula, 2014). Contrary cultural ideal's, each style of yoga has its own unique techniques and characteristics (Li & Goldsmith, 2012; Subedi, 2014). Although one style of yoga may not be considered 'better' over another, 38% of yoga studies within the review of Cramer et al. (2016) did not clearly define the style of yoga practiced. A gap within the research is presented due to the lack of specific psycho-physiological responses respective to particular yoga styles and their associated FITT principles. This gap creates confusion and overgeneralizes the practice of *yoga* and tends to ignore other aspects of the traditional Eastern practices such as deep contemplation, relaxation, and meditation techniques.

Variable Intensities of Yoga

Common yoga styles that incorporate *asana* as a component within practice are Hatha, Viniyoga, Kundalini, Ashtanga, Anasara, Iyengar, and Bikram (Cramer et al., 2016; Sheffield & Woods-Giscombé, 2016). By knowing the intensity of yoga styles, health professionals and educators will be able to offer proper recommendations for future patients. Table 2.1 is a brief summary of yoga and the various intensities that it can entail.

For example, power or high intensity types of yoga may not be recommended for all populations. Ashtanga yoga, commonly referred to as 'power' yoga, could be a vigorous physical exercise for cancer or fatigued patients (Subedi, 2014). Another example, the 105 degree Fahrenheit temperatures and excessive sweat loss in a Bikram yoga class may be dangerous for individuals recovering from heart or lung disease (Subedi, 2014).

Studies support that there are a variety of the physiological responses to different forms of yoga practice (Cowen & Adams, 2007; Hopkins et al., 2016). Although the intensity of a yoga session is dependent on the fitness level of the individual practicing, yoga and its respective eight limbs each have different energy expenditures (Cowen & Adams, 2007; Hagins et al., 2007).

The definition of *vinyasa* is to link breath with movement and it is a portion of the *asana* practice within a yoga session. *Vinyasa* is commonly referred to as the continuous flowing of postures in a sequence called sun or moon salutations. The sun salutation portion of yoga classes, consistently expends more energy than the non-sun salutation portion (Clay et al., 2005; Hagins et al., 2007). The intensity of a yoga practice can vary by the speed of the Sun Salutations performed. Different speeds of sun salutations (high vs. standard speed) were shown to produce different energy expenditures, muscular activation, cardiovascular output, and hormonal responses (Potiaumpai et al., 2017, 2016).

Table 2.1 - Yoga Practices & Intensities			
Study	**Type(s) of Yoga**	**Length of Time**	**Description of Exercise Intensity**
(Abel, Lloyd, Williams, & Miller, 2012)	Bikram	90 min	• Not equivalent to moderate physical activity • Bikram yoga training had no effect on the major variables of pulmonary function
(Hagins, Moore, & Rundle, 2007)	Hatha yoga w/ sun salutations	N/A	• Total yoga session was not equivalent to moderate intensity physical activity • Yoga is equivalent to walking at ~2mph on treadmill • The more sun salutations within the practice the more energy intensive and could be considered mild-moderate aerobic exercise.
(Clay, Lloyd, Walker, Sharp, & Pankey, 2005)	Hatha	30 in	*Average Energy Expenditure* • Sun Salutations: 3.76 ± 1.03 kcal/min • Non-Sun Salutation 2.28 ± 0.59 kcal/min • Yoga has a higher heart rate response in comparison to rest, but lower than walking at 3.5 mph
(Cowen & Adams, 2007)	Ashtanga, Hatha, Gentle	N/A	• Heart rates increase across all styles of yoga during practice • Ashtanga yoga has a significantly higher average heart rate (54%) compared to hatha (48%) and gentle yoga (42%) • Ashtanga yoga is a moderate aerobic exercise, Hatha and Gentle Yoga are not
(Helgadóttir, Hallgren, Ekblom, & Forsell, 2016)	Yoga-based stretching & balance exercises	55 min	• Not moderate intensity according to ACSM standards
Potiaumpai et al, 2016	HSY & SSY	8 min	• HSY 5.43 kcal/min • SSY 3.30 kcal/min
Potiaumpai et al, 2017	HYS & SSY	8 min	• HSY – more muscular activation • SSY – less muscular activation
(Ray, Pathak, & Tomer, 2011)	Hatha Yoga	60 min	• Asanas performed were between 9.9 - 26.5% of VO2max *Average Energy Expenditure* • 55.45 kcal/min energy expended within total session • Asanas(postures) 2.29 kcal/min; >2 METS • Breathing Maneuvers 1.91 kcal/min; 1-2 METS • Meditation 1.37 kcal/min; 1 MET

Table 2.1 – Yoga Practices & Intensities. – Brief summary yoga practices within the research and their respective intensities.

There is a debate within the literature whether or not yoga is considered to be a moderate intensity exercise that meets the World Health Organization's (2018) recommendations. There are aerobic benefits to yoga *asana* and *pranayama* practices (Cowen & Adams, 2007; Ray et al., 2011). Yoga *asanas, vinyasa* flows, and sun salutations are generally defined as mild-moderate exercises (Hagins et al., 2007; Larson-Meyer, 2016; Potiaumpai et al., 2016), in some cases potentially reaching vigorous intensities (Subedi, 2014). As previously mentioned, one must surpass a moderate intensity threshold to elicit a cortisol response to exercise-induced stress. By reaching the moderate intensity exercise threshold via yoga *asana* practices, one could theoretically cross the threshold needed to stimulate a cortisol response 15-30 minutes after a yoga session. With consistent yoga training over time, one could potentially enhance the elasticity of the HPA axis and cortisol regulation.

Yoga Influences the HPA Axis

From the psychopathology perspective, yoga practices can be considered a valid substitute to pharmaceutical therapies for some individuals with depression and anxiety (Li & Goldsmith, 2012; Thirthalli et al., 2013). This would decrease the risk of pharmaceutical side effects and could enhance a normal homeostatic balance of the HPA axis through holistic practices. Understanding the differentiations of yoga style intensities and their psycho-neuroendocrine responses is vital for comprehending the mechanisms in which yoga can affect the HPA axis (Hellhammer et al., 2009; Kudielka et al., 2009).

Research supports that yoga influences the regulation of the HPA axis and in many cases impacts cortisol levels. Eighteen studies that are directly related to this stress-biomarker and yoga were reviewed for the purposes of this literature review. Sixteen of these studies revealed that yoga had a significant impact on cortisol concentration and HPA axis regulation. Reference Table 2.2 in Appendix H includes a summary of yoga studies and their respective cortisol response outcomes.

The multifaceted approach of yoga affects the complex psychoneuroendocrine systems within the body to produce a response within the HPA axis (Kamei et al., 2000; Raub, 2002; Thirthalli et al., 2013). Stress-free states, occurring in *savasana*, *pranayama*, and *dhyana* portions of a yoga practice, are highly correlated with frontal lobe alpha wave activity, complemented by a decrease in cortisol levels (Kamei et al., 2000). Other studies suggest that yoga has an ameliorating effect on the HPA axis to create an optimized secretion of cortisol, thus promoting homeostatic balance through the autonomic reflex regulatory mechanisms (Gopal et al., 2011). Other theories as to how the practice of yoga can affect the HPA axis are through: (i) an increase in vagal activity (Field, 2011); (ii) the enhancement of homeostasis through the balance of the PNS and gamma-aminobutyric acid (GABA) systems (Thirthalli et al., 2013); (iii) the reduction in activation of the hippocampus and amygdala due to a change in threat perception, emotion regulation, and stress activity (Pascoe & Bauer, 2015; Streeter et al., 2012; Thirthalli et al., 2013); (iv) the activation of the prefrontal cortex and increased glutamate transmission in the arcuate nucleus of the medial hypothalamus (Li & Goldsmith, 2012; Thirthalli et al., 2013); and (v) the regulation of circadian rhythms and sleep patterns (Batista et al., 2015; Kamei et al., 2000; Streeter et al., 2012; Vera et al., 2009).

YOGA CLASS DESIGN & THEORY OF ENERGETIC SEQUENCING

BRAHMANA/LANGHANA STRATEGY & PARA YOGA BLUEPRINT

Upon writing this review of literature, no studies have approached treating a population with yoga classes infused with the *brahmana/langhana* strategy (BLS) of Kraftsow (1999) and the Para Yoga Blueprint (PYB) of Mirsky (2016). In theory, by utilizing the PYB as a sequencing tool to develop a yoga class sequence, the teacher or practitioner would be inherently following the BLS. Both of these two yogic approaches are structured around Eastern *Ayruvedic* paradigms. Overall, the combination of these two sequencing methods are designed to provide less suffering from depression and anxiety by bringing the physical body and the *gunas*, or energetic qualities of the mind, into balance with each other.

The BLS contains two specific *Ayruvedic* components: *brahmana* and *langhana. Brahmana* means to build up or expand, while *langhana* means to reduce and calm. The BLS uses these concepts to increase PA within the body (*brahmana*), then to calm the body through breath work and postures that enhance the activation of the PNS (*langhana*). *Asanas*, or postures, that induce *brahmana* qualities are geared towards strengthening and moving the body via *vinyasa* flows, backbends, extensions, and laterals. *Asanas* that induce *langhana* qualities bring balance and stabilization back to the emotional states of mind via practicing longer holds in supported forward folds, supine twists, slowed breath work with focus on the exhales, relaxation, and meditation.

The overall goal of the BLS is to balance the *gunas* of the mind with the physical body. The three predominate energetic qualities of the mind (*gunas)* are *sattva, raja,* and *tama.* One *guna* is not characteristically more important that another. Each *guna* serves a specific purpose for an individual's health and well-being. Theoretically, disease occurs when the quality or state of a *guna* becomes excessive.

Sattva energetic qualities are of balance, harmony, and equilibrium and can be further described as emotions and attitudes of appreciation, bliss, compassion, courage, happiness, joy, honesty, patience, tenderness, and tolerance. The energetic qualities of the *raja guna* are activity and creativity, but when in excess, it can produce attitudes and emotions described as anger, annoyance, anxiety, apprehension, aversion, fear, hostility, impatience, insecurity, irritation, nervousness, and worry. The *tama guna* is an energetic quality of stability, although when stability sets in for prolonged periods of time, the inertia to move becomes difficult and depression is possible. *Tamasic* attitudes and emotions can be described as complacency, despair, disappointment, emptiness, gloom, grief, hopelessness, loneliness, self-pity, and shame. Strong states of the *raja* and *tama gunas* are hypothesized to produce symptoms of anxiety and depression due to amplified firing within the HPA axis (Kraftsow, 1999).

Additionally, to support the sequence of the BLS of Kraftsow (1999) is the Para Yoga Blueprint (PYB) from Karina A. Mirsky (2016). The structure of the PYB provides a foundation to follow the BLS. Reference Table 2.3 (duplicated from Chapter I) to see these two sequencing concepts matched-up to each other.

Table 2.3 - *Brahmana/Langhana* Strategy & Para Yoga Blueprint Concept Match-Up (Duplicated from Chapter I)	
Brahmana/Langhana Strategy (Kraftsow, 1999)	Para Yoga Blueprint (Mirsky, 2016)
Brahmana Inducing (to energize, build up)	Centering
	Warms Ups
	Vinyasa Flows
	Standing Poses
	Transition to Floor Poses
	***Inversions (N/A for this study)
	Back Bends
Langhana Inducing (to calm, reduce)	Twists
	Forward Bends
	Savasana
	Pranayama
	Meditation

Table 2.3 – BLS & PYB Concept Match-Up (Duplicated from Chapter I). This table depicts how the BLS concepts match to their corresponding section within the PYB. ***Inversions were removed from this study due to the novice population participating within this project.

The PYB provides structural framework to enhance the strategies of the BLS. These sequencing concepts are hypothesized to reduce the excessive firing the HPA axis which could help decrease symptoms of anxiety and depression. Theoretically, yoga sessions infused with the BLS and PYB could be a non-pharmaceutical alternative solution for individuals suffering from depression and anxiety, such as nursing students.

REVIEW OF LITERATURE SUMMARY & CONCLUSON

Due to the excessive amount of stress reported in nursing students, this population is in need of stress management interventions because they are at risk for stress-related diseases, such as depression, anxiety, substance abuse, and obesity. The complexity of the HPA axis is influenced by many variables, all of which could affect an individual's cortisol response when presented with a stressful situation. Yoga is a light-moderate intensity practice that is effective in regulating cortisol and reducing stress, but the specific mechanisms are not clearly defined due to the differentiations between yoga styles.

Further research is needed (i) to understand the psycho-physiological differences between styles, types, and lineages of yoga and their respective effects on the HPA axis and (ii) to explore the potential effect from the energetic sequencing concepts of the BLS and PYB. By implementing new research, health care providers will be able to prescribe appropriate yoga interventions to help minimize deleterious health outcomes in at risk populations, such as nursing students.

CHAPTER THREE: CONCLUSIONS & FUTURE RESEARCH

Nursing students commonly have negative stress coping habits and are at risk for developing stress-related diseases, such as anxiety and depression. There is a clear need for healthy stress management interventions for their psycho-physiological well-being. In this study, we collected salivary cortisol responses from eight female nursing students who participated in three different speeds of yoga. Each of the three yoga sessions were infused with the Eastern yogic concepts of the BLS and PYB, which were hypothesized to reduce the stress biomarker.

One of the most challenging aspects of cortisol stress research is the vast amount of individualism that subjects (and researchers) bring into the experiment. One must attempt to control for these variables that influence cortisol via meticulous collection and analysis techniques.

When the Eastern *Ayruvedic* philosophies of yoga mix with Western yoga science, it can be difficult to measure protocol effectiveness. This is the first academic study with yoga class designs infused with the PYB and BLS. Although there was a significant reduction in cortisol due to yoga classes infused with the BLS and PYB, the positive outcomes cannot be fully attributed to these chronological sequencing concepts. Future research should consider controlling for these concepts to compare and contrast the effectiveness of cortisol responses from classes designed with the BLS and PYB. This will help to identify whether or not these sequencing concepts could enhance the health and well-being of chronically stressed populations.

Although this study cannot claim any positive longitudinal effects, it provided strong evidence that a single yoga session, totaling 70 minutes (50 –minute *asana* practice followed by 20 minutes of relaxation, breathing, and meditation), cadenced at High, Standard, and Slow speeds, significantly reduced salivary cortisol levels within female nursing students. Regardless to the speed performed, yoga provided an acute reduction in cortisol. The significant acute decreases in the stress biomarker, cortisol, suggests that yoga has a downregulating effect on the HPA axis, which could provide an immediate benefit to the chronically stressed nursing student population.

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APPENDICES

A. Project Renewal Form – NMU IRB
B. Memorandum of Approval for Modifications
C. Letter of Consent
D. Health History Intake Form
E. PAR-Q Form
F. Weekly Self-Reported Questionnaires
G. Flow Chart Permission – Hannibal & Bishop (2014)
H. Table 2.2 – Yoga & Cortisol Responses

APPENDIX A – PROJECT RENEWAL FORM WITH NMU IRB

Project Renewal Form (without modification) for Research Involving Human Subjects

NMU Institutional Review Board (IRB)

NORTHERN MICHIGAN UNIVERSITY

Submission of this Project Renewal Form will be conducted electronically according to the following procedure:

1. After completing this form, the principal investigator will forward the form to the Department Head for approval.

2. If the Department Head approves the project, s/he will forward the application electronically to the administrative assistant to the IRB (jantaylo@nmu.edu) and the IRB chair (dereande@nmu.edu). Please copy the principal investigator on the e-mail.

Submission of this application signifies that you have read the NMU IRB Policy Manual and agree to adhere to the procedures and policies explained therein. If any unanticipated problems arise involving human subjects, you must immediately notify the IRB chair (dereande@nmu.edu) and NMU's IRB administrator (rwinn@nmu.edu).

Human Subjects Project Number: HS17-827

Principal Investigator: x mhenneke@nmu.edu	Department: SHHP	E-mail:
Co-Investigator: x ljoubert@nmu.edu	Department: SHHP	E-mail:
Co-Investigator:	Department:	E-mail:

Project Title:

Old title: Effects of Yoga and Walking on Nursing Student Serum Cortisol Levels

New title: Three different styles of yoga and their respective acute effect on salivary cortisol levels in female nursing students.

APPENDIX B – MEMORANDOM AND APPROVAL FOR MODIFICATIONS

MEMORANDUM

TO: Meagan Hennekens
School of Health and Human Performance

CC: Lanae Joubert
School of Health and Human Performance

FROM: Robert Winn, Ph.D.
Interim Dean of Arts and Sciences/IRB Administrator

DATE: March 22, 2017

RE: Modification to HS17-827
IRB Approval Dates: 2/2/2017 - 2/28/2018
Proposed Project Dates: 3/15/2017 – 12/31/2017
"Effects of Yoga and Walking on Nursing Student Serum Cortisol Levels"

Your modification for the project "Effects of Yoga and Walking on Nursing Student Serum Cortisol Levels" has been approved under the administrative review process. Please include your proposal number (HS17-827) on all research materials and on any correspondence regarding this project.

Any additional changes or revisions to your approved research plan must be approved by the IRB prior to implementation. Unless specified otherwise, all previous requirements included in your original approval notice remain in effect.

If you complete your project within 12 months from the date of your approval notification, you must submit a Project Completion Form for Research Involving Human Subjects. If you do not complete your project within 12 months from the date of your approval notification, you must submit a ProjectRenewal Form for Research Involving Human Subjects. You may apply for a one-year project renewal up to four times.

NOTE: Failure to submit a Project Completion Form or Project Renewal Form within 12 months from the date of your approval notification will result in a suspension of Human Subjects Research privileges for all investigators listed on the application, until the form is submitted and approved.

If you have any questions, please contact me.

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APPENDIX C – INFORMED CONSENT FORM

Northern Michigan University
School of Health and Human Performance
Graduate Student Research Study
Informed Consent Form

Study Title:
Three styles of yoga and their respective effect on salivary cortisol levels in female nursing students

Date: ____(Month/Day/Year)
Name: ____(Clearly Print Name)
E-mail Address: ____(Clearly Print E-mail Address)

We are inviting you to participate in a research study involving yoga and female nursing students. The purpose of the study is to assess how three different styles of yoga impact your acute stress response via a salivary biomarker, cortisol.

WHO WE ARE LOOKING FOR?

Requirements to be a participant in this study are as follows:

- Currently enrolled as a nursing student or as a pre-nursing student at NMU
- Female whom is not pregnant
- Age: 18-32 years
- Body Mass Index is below 40
- Yoga experience: no prior yoga experience within the past 2 months
- Physical Activity Minutes: subject reported no more than 300 minutes of moderate physical activity throughout a school week
- Answered "No" to all of the Physical Readiness questions on the PAR-Q & YOU Form
- Health History: Overall healthy person. You are not pregnant or 1-5 weeks postnatal, do not have major injuries, and are not taking or have not taken medications with dexamethasone, glucocorticoids, cortisone, or prednisolone within the past 6 months.

WHAT AM I SIGNING UP FOR?

This research study will take place on NMU's campus during the Fall 2017 semester. This study has been approved by NMU's IRB: Project #HS17-827. You will be required to attend one demonstration day and three yoga sessions that will consist of one style of yoga on each day (*not necessarily in this order*): [1] Restorative/Yin Yoga, [2] Standard Speed Yoga, and [3] High Speed Yoga. The duration of each yoga class will be 1 hour long and will be spread out over the course of 5 weeks. Your total time commitment to this project will be no longer than 7 hours.

You will be blinded to the styles of yoga you will be practicing throughout the study. The styles of yoga practiced will be revealed to all participants after all of the twelve salivary sample collections and the three yoga sessions have been completed. This is to control for possible psychological stressors of anticipating which type of yoga you will be performing. (i.e.: anxiety, fear, doubt)

All classes will be taught for a beginner level, novice yoga practitioner to ensure safety and minimize physical injury risk. All yoga classes will be taught by a 200 hour Experienced Registered Yoga Teacher through Yoga Alliance, whom has been certified since 2010, and is insured through K & K Insurance Group, Inc.

You will be required to provide a salivary sample four times during each yoga session. Your saliva will be analyzed for cortisol, the stress hormone, and the respective acute stress response to different styles of yoga. About 5mL (~1 teaspoon) of saliva will be collected for each sample. A total of 20 mL (~4 teaspoons) will be collected during each yoga session. Therefore, 60mL of saliva (~4 tablespoons) will be collected over the course of the 3 yoga sessions (September 14th, September 28th and October 12th) in total.

The prospective outline below describes the time requirements that would be necessary to fulfill the intended purposes of this study. Again, at most, your time commitment will be about 7 hours for this study.

Three Different Styles of Yoga and the Respective Effect on Salivary Cortisol Levels in Female Nursing Students *Time Commitment & Salivary Sample Collection Schedule*		
Date	**Activity**	**Time Commitment**
Tuesday September 12th, 2017	• Informative/ Demo Day • Informed Consent Day	5:00 – 6:00pm West Science 1702

<table>
<tr><td>Week 1</td><td></td><td></td></tr>
<tr><td>Thursday September 14th, 2017

Week 1</td><td>Yoga Session (1 of 3)
Subjects will not know which type of yoga they practice until they finish the last salivary sample collection on October 12th.</td><td>5:00pm – 7:00pm
West Science 1702

• 5:00pm - 5:05pm –
○ 1st Salivary Sample Collection - Pre-Exercise Measurement (~5mL)
• 5:05pm – 5:50 pm –
○ (1 of 3) Asana Yoga Session 45 minutes
• 5:50 pm - 5:55pm:
○ 2nd Salivary Sample Collection - Immediate-Post Measurement after Asana/Posture practice before Savasana/Meditation (~5mL)
• 5:55pm – 6:10pm –
○ 15 minutes of savasana/meditation
• 6:10 pm - 6:15pm –
○ 3rd Salivary Sample Collection – Post Savasana/Meditation (~5mL)
• 6:30 pm - 6:35pm –
○ 4th Salivary Sample Collection - 30 minute-Post Exercise Measurement (~5mL)</td></tr>
<tr><td colspan="3">Week 2 – No yoga practice</td></tr>
<tr><td>Thursday September 28th, 2017

Week 3</td><td>Yoga Session (2 of 3)
Subjects will not know which type of yoga they practice until they finish the last salivary sample collection on October 12th.</td><td>5:00pm – 7:00pm
West Science 1702

• 5:00pm - 5:05pm –
○ 5th Salivary Sample Collection - Pre-Exercise Measurement (~5mL)
• 5:05pm – 5:50 pm –
○ (2 of 3) Asana Yoga Session 45 minutes
• 5:50 pm - 5:55pm:
○ 6th Salivary Sample Collection - Immediate-Post Measurement after Asana/Posture practice before Savasana/Meditation (~5mL)
• 5:55pm – 6:10pm –
○ 15 minutes of savasana/meditation
• 6:10 pm - 6:15pm –
○ 7th Salivary Sample Collection – Post Savasana/Meditation (~5mL)
• 6:30 pm - 6:35pm –
○ 8th Salivary Sample Collection - 30 minute-Post Exercise Measurement (~5mL)</td></tr>
<tr><td colspan="3">Week 4 – No yoga practice</td></tr>
<tr><td>Thursday October 12th, 2017

Week 5</td><td>Yoga Session (3 of 3)
Subjects will not know which type of yoga they practice until they finish the last salivary sample</td><td>5:00pm – 7:00pm
West Science 1702

• 5:00pm - 5:05pm –
○ 9th Salivary Sample Collection - Pre-Exercise Measurement (~5mL)
• 5:05pm – 5:50 pm –</td></tr>
</table>

	collection on October 12th.	o (3 of 3) Asana Yoga Session 45 minutes • 5:50 pm - 5:55pm: o 10th Salivary Sample Collection - Immediate-Post Measurement after Asana/Posture practice before Savasana/Meditation (~5mL) • 5:55pm – 6:10pm – o 15 minutes of savasana/meditation • 6:10 pm - 6:15pm – o 11th Salivary Sample Collection – Post Savasana/Meditation (~5mL) • 6:30 pm - 6:35pm – o 12th Salivary Sample Collection - 30 minute-Post Exercise Measurement (~5mL)

You will be asked to *not* participate in any yoga activities throughout the 5-week length of study, besides what will be offered within the study design. You will be asked to *not* participate in any additional physical activity minutes that originally reported on your Health Intake Form.

The best results for salivary cortisol analysis are obtained when subjects adhere to a few guidelines. It is crucial that you are willing to commit to the following protocol for the accuracy of the salivary sample collections:

- You should not brush your teeth within 45 minutes prior to sample collection.
    - This means you would be asked to *not* brush your teeth from about 4:00 pm until after the last salivary sample was collected for each yoga session day.
- Dental work should not be performed within 24 hours prior to sample collection.
- Avoid foods with high sugar or acidity, or high caffeine content, immediately before sample collection, since they may compromise the assay by lowering saliva pH and increasing bacterial growth.
- Avoid consumption of alcohol, caffeine, nicotine, and prescription/over-the-counter medications within the prior 12 hours.
    - If consumption of any of the above substances are taken within the 12-hour window prior to the first salivary sample collection, you will be required to report when and how much of each substance you have consumed.
- Avoid vigorous physical activity on the day of salivary sample collections.
- Do not eat a major meal within 60 minutes of sample collection.
    - This means you would be asked to *not* eat a major meal after 3:45pm until after the last salivary sample was collected for each yoga session day.
- You can rinse mouth with water to remove food residue and wait at least 10 minutes after rinsing to avoid sample dilution before collecting saliva.
    - This means that if you want to rinse out your mouth, you would be asked to rinse your mouth out with water prior to 4:45 pm

until after the last salivary sample was collected for each yoga session day.

WHAT'S IN IT FOR ME?

Participating in a scientific experiment can contribute to your overall learning of science. Moreover, we want to reward your participation for being involved. Although there will be no cash compensation for this study, you are encouraged to complete all 3 yoga sessions and 12 salivary sample collections for a few incentives. You will receive the following incentives listed below depending on your participation in this study.

You must complete ***all twelve salivary sample collections*** and ***all three yoga sessions*** to be eligible to:

- Receive one *free* yoga mat for attending
- Receive one *free* yoga class for you to redeem at your leisure
- Receive one *free* yoga class for a friend
    - ***Friend must attend the same class (on the same day) you are attending
- Have a chance to win *FREE 5-class package* (drawing held at end of study for all compliant participants)

Yoga class incentives and class packages will be offered through Rohana Yoga & Wellness, a local yoga studio in downtown Marquette, MI. All yoga teachers at Rohana Yoga & Wellness are 200 hour certified through Yoga Alliance.

WHAT ARE MY RISKS?

We will keep all of the information you provide to the researchers confidential; however, federal regulatory agencies and the Northern Michigan University Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research. Coding will be used to ensure privacy. Your identity will remain anonymous in any written reports regarding this study. More specific risks are outlined here:

- *Physical Risk:* There is a low level of physical risk within this study. The classes will be led by a Yoga Alliance certified and insured yoga teacher whom will ensure proper form and techniques are being utilized. Individuals that fit the study criteria and whom are free of contraindications to exercise based on the PAR-Q & YOU Form and Health History Intake Form will be eligible to participate within the study. As with any physical activity, there is a potential of injury. Although not common, injuries from yoga may include; pulling or straining a muscle, joint pain and/or strain, bulging discs, lower back pain, tendon and ligament tears.

- *Time Commitment/Stress Risk*: The time commitment given to this study could create another stressor both on the psychological and academic levels.
- *Mental/Emotional Response Risk:* The practice of yoga consists of relaxation and meditation. These types of techniques may cause a mental or emotional response for some individuals.
- *Saliva Collection:* We will employ only single-use salivettes for each sample collected to prevent possible contamination between research subjects. Researchers assisting with collections will wear gloves and will change gloves between assistance.
- *Pregnant:* The yoga teacher will be a Registered Prenatal Yoga Teacher certified through Yoga Alliance. If a woman becomes pregnant throughout the course of the study, the yoga teacher will be able to modify classes to her needs and abilities. The woman may stay in the study and participate in the yoga sessions and salivary sample collections if she chooses, but the data will not be used due to cortisol fluctuations with pregnancy.

Taking part in this research study is completely voluntary. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized. Although there is no cost or payment to participate, each subject whom has completed the above mentioned activities will be eligible for the respective rewards.

WHO DO I CONTACT WITH QUESTIONS/CONCERNS?

If you have any further questions regarding your rights as a participant in a research project you may contact Dr. Robert Winn of the Human Subjects Research Review Committee of Northern Michigan University (906-227-2300) rwinn@nmu.edu. Any questions you have regarding the nature of this research project will be answered by the principal researcher, Meagan R Hennekens, or her thesis adviser, Dr. Lanae Joubert. Contact Meagan via e-mail, mhenneke@nmu.edu, or by phone, 1-651-271-8496. Contact Dr. Lanae Joubert via e-mail ljoubert@nmu.edu, or by phone, 1-906-227-2137.

I GET IT - SIGN ME UP!

I have read the above "Informed Consent Statement." The nature, risks, demands, and benefits of the project have been explained to me. I understand that I may ask questions and that I am free to withdraw from the project at any time without incurring ill will or negative consequences. I also understand that this informed consent document will be kept separate from the data collected in this project to maintain anonymity (confidentiality). Access to this document is restricted to the principle investigator.

-- ---------------------------

Your signature that you agree you are informed Date

Thank you very much for your willingness to participate within this research study. Signing this form indicates your willingness to participate in this yoga research study.

Sincerely,

Meagan R Hennekens BS LMT 200 ERYT PRYT
Principle Investigator
NMU Hearts of Yoga President
E-mail: mhenneke@nmu.edu
Phone: 651 271 8496

Lanae Joubert, PhD, RD
Graduate Student Thesis Director
Assistant Professor of Nutrition
E-mail: ljoubert@nmu.edu
Phone: (906)227-2137

APPENDIX D – HEALTH HISTORY INTAKE FORM

NMU School of Health and Human Performance

REGISTRATION – HEALTH HISTORY – INTAKE FORM

Three style of yoga and the respective acute effects in salivary cortisol levels within female nursing students.

Today's Date:		*SUBJECT CODE FOR CLS - Researcher USE ONLY:*	

SUBJECT INFORMATION

Last name: First:	Middle:		Year of Nursing School (please circle one): 1st 2nd 3rd 4th 5th ++		
Birth date:	Age:	Sex:	Height:	Weight:	
Race:	E-mail Address:				
Address:					
Home phone no.:	Cell phone no.:				

HEALTH AND ACTIVITY HISTORY INFORMATION

Please answer the following questions by marking the corresponding Yes/No or writing in numerical data to the right-hand side of the question.

Are you pregnant?	◯ Yes ◯ No	Do you have HIV/AIDS?	◯ Yes ◯ No	Do you have any autoimmune deficiency diseases?	◯ Yes ◯ No
Are you over 6 weeks postnatal?	◯ Yes ◯ No	Do you have Hepatitis A, B or C?	◯ Yes ◯ No	Do you have high or low blood pressure?	◯ Yes ◯ No
Are you currently taking or have taken any medication with dexamethasone, glucocorticoids, cortisone, or prednisolone within the past 6 months?	◯ Yes ◯ No	Have you had any major injuries within the past 6 months that would inhibit you from partaking in moderate intensity weight-bearing physical activity exercises?	◯ Yes ◯ No	Have you received any information from your health care physician saying that you are not able to partake in moderate intensity physical activity exercises?	◯ Yes ◯ No
Have you ever practiced yoga before?	◯ Yes ◯ No	Do you obtain over 150 minutes of moderate physical activity per week?	◯ Yes ◯ No	Have you used tobacco products within the past 6 months?	◯ Yes ◯ No
Have you practiced yoga within the past 2 months?	◯ Yes ◯ No	What is the average amount of physical activity minutes you obtain throughout a school week?	Physical Activity minutes per week during the semester:___________	Do you have a fear of needles or blood?	◯ Yes ◯ No
FOR RESEARCHER USE ONLY: ***Subjective Average Moderate Physical Activity Minutes per week***		PA min. for first Yoga Session Wee 1:	PA min. for second Yoga Session Week 2:	PA min. for third Yoga Session Week3:	

Please list all medications you are currently taking:

Please list all supplements you are currently taking:

Please list all major injuries that have happened within the past 6 months:

Subjective Stress Load On a scale from 1-10 how much stress do you have in your life? 1 = Stress Free 10 = Overloaded with Stress (Pre)_____ (1)_____ (2)_____ (3)_____	**Subjective Stress Management Level** On a scale from 1-10 how well do you manage the stress within your life? 1= Perfect at managing my stress. 10= I do not know how to manage my stress at all (Pre)_____ (1)_____ (2)_____ (3)_____

IN CASE OF EMERGENCY

Name of local friend or relative (not living at same address):	Relationship to Subject:	Home phone no.:	Work/Cell phone no.:

Signatures required on the other side of the document

Permissions to:

The above information is true to the best of my knowledge. I also authorize the NMU School of Health and Human Performance, Meagan Hennekens, and/or other researchers involved within this study to use my health information for research purposes only. I understand that the personally identifiable information from this form will not be used in any publications.

Subject Signature	Date

APPENDIX E – PAR-Q & YOU

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ____

SIGNATURE ________________________________ DATE ________________________

SIGNATURE OF PARENT
or GUARDIAN (for participants under the age of majority) ________________________ WITNESS ________________________

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

APPENDIX F – WEEKLY SELF-REPORTED QUESTIONNAIRE

Date: ________________

Name: ________________________________

Weekly Physical Activity Minutes: __________

Subjective Stress Load: ___________________

(1 = Stress Free >>>10 = Overloaded with Stress)

Subjective Stress Management Level: ______

(1= Perfect at managing stress >>> 10 = I do not know how to manage my stress at all)

Have you consumed any medications/over-the-counter drugs/caffeine/ nicotine/alcohol since 5 am?

____

If yes, please list what substances you have consumed, when, and how much you have consumed since 5 am.

____
____
____

Date: ________________

Name: ________________________________

Weekly Physical Activity Minutes: __________

Subjective Stress Load: ___________________

(1 = Stress Free >>>10 = Overloaded with Stress)

Subjective Stress Management Level: ______

(1= Perfect at managing stress >>> 10 = I do not know how to manage my stress at all)

Have you consumed any medications/over-the-counter drugs/caffeine/ nicotine/alcohol since 5 am?

____

If yes, please list what substances you have consumed, when, and how much you have consumed since 5 am.

____
____
____

Date: ________________

Name: ________________________________

Weekly Physical Activity Minutes: __________

Subjective Stress Load: ___________________

(1 = Stress Free >>>10 = Overloaded with Stress)

Subjective Stress Management Level: ______

(1= Perfect at managing stress >>> 10 = I do not know how to manage my stress at all)

Have you consumed any medications/over-the-counter drugs/caffeine/ nicotine/alcohol since 5 am?

____

If yes, please list what substances you have consumed, when, and how much you have consumed since 5 am.

____
____
____

Date: ________________

Name: ________________________________

Weekly Physical Activity Minutes: __________

Subjective Stress Load: ___________________

(1 = Stress Free >>>10 = Overloaded with Stress)

Subjective Stress Management Level: ______

(1= Perfect at managing stress >>> 10 = I do not know how to manage my stress at all)

Have you consumed any medications/over-the-counter drugs/caffeine/ nicotine/alcohol since 5 am?

____

If yes, please list what substances you have consumed, when, and how much you have consumed since 5 am.

____
____
____

APPENDIX G – FLOW CHART PERMISSION - HANNIBAL & BISHOP (2014)

NORTHERN MICHIGAN UNIVERSITY

Mail | COMPOSE | Inbox | Starred | Important | Sent Mail | **Drafts (32)** | 2017 X-mas Gifts | backup.pst | Meagan

More | 1 of 15

Meagan Hennekens <mhenneke@nmu.edu> 5:31 PM (24 minutes ago)

to kara.e.hannibal

Dear Dr. K. Hannibal,

My name is Meagan R Hennekens and I am a graduate student at Northern Michigan University within the School of Health and Human Performance. I am currently writing my thesis project with the following title: "Three speeds of yoga and salivary cortisol response in female nursing students."

I have come across the flow chart that you have created for the following article: Chronic Stress, Cortisol Dysfunction, and Pain: A Psychoneuroendocrine Rationale for Stress Management in Pain Rehabilitation. This figure helps to explain the complex relationship between cortisol and chronic stress. I am wondering if you would be willing to let me have permission to use this flowchart for my thesis project? I wouldn't change any of the pieces within the chart.

Sincerely,
Meagan Rose

Meagan R Hennekens BS LMT 500 RYT 200 E-RYT PRYT
NMU Hearts of Yoga Club Vice President
E-mail: mhenneke@nmu.edu OR mrhennekens@gmail.com
Cell Phone: 651 271 8496

No recent chats
Start a new one

Kara Hannibal 5:44 PM (11 minutes ago)

to me

Hi Meagan,

No problem, just cite the article per standard guidelines. Sounds like an interesting project, I'm glad the flowchart is helpful.

Kara

APPENDIX H – TABLE 2.2 YOGA & CORTISOL RESPONSES

Table 2.2 Yoga & Cortisol Responses
Literature Review Table

Authors	Population/ Subjects/Groups	Groups & Yoga Descriptions	Intensity of Yoga	Study Design	Cortisol Outcomes/Conclusions
(Batista et al., 2015)	22 Volunteers 7 Males & 15 Females Age 23 ± 3 yrs	**Tantra Yoga Group:** Bhujangasana (snake posture), Naokasana (boat posture), Yoga mudra, Karmasana, self-massage, and deep relaxation.	Not Specified	**Length of Study:** 6 weeks **Duration of Yoga Session:** 50 min yoga sessions twice per week **Cortisol:** Salivary **Time of Day:** - Collected at 7:30 am, 9 am, 12pm & 10 pm	**Acute:** 24% decrease in salivary cortisol from one 50 minute yoga session **Chronic:** Tantra Yoga Group had higher cortisol production in the morning, lower production in the evening, and lower values before sleep vs Control Group
(Benvenutti et al., 2017)	24 Healthy Young Adults 13 Males & 11 Females Age 22.9 ± 3.5 yrs	**Hatha Yoga Group [A]**: Video with series of easy body postures combined with meditation and breathing instruction **Control Group [B]**: Informational video on the history of yoga	Yoga suitable for participants with all levels of experience	**Length of Study:** Randomized-crossover trial within 48 hours **Duration of Yoga Session:** 30 min video each session **Cortisol:** Salivary; 3 time-points: (i) baseline, (ii) post-stress task, & (iii) 15 min post-recovery **Time of Day:** Between 1 & 4pm	**Acute:** Decrease in cortisol levels in the intervention group - lower cortisol AUC for the yoga condition (122.5 ± 91.7) compared with the control condition (165.4 ± 122.2) ($p = 0.01$) **Chronic:** Cumulative acute effects of yoga on stress reactivity and recovery may contribute to the benefits of the long-term practice
(Bershadsky, Trumpfheller, Kimble, Pipaloff, & Yim, 2014)	51 Pregnant Women Initial Mean Gestational Age 15.2 wks (Range: 12-19 wks) Mid-Study Mean Gestational Age 25.9 wks (Range: 22-31 wks)	**Hatha Yoga Prenatal Group [A]** Each session; (i) 10-15 min dialogue, (ii) 60 min asanas (i.e., body postures), (iii) 10 min stretching, and (iv) 5 -10 min savasana (i.e., final relaxation), with pranayama (i.e., breathing) instruction throughout the practice. Emphasis on squats and balance poses, chest & hip openers, and restorative postures with props. **Control Group [B]**: No intervention	Yoga group was instructed to follow the yoga video to the best of their ability	**Length/Duration:** 90 min yoga session twice throughout the course of pregnancy **Cortisol:** Salivary - (i)baseline: 5 min prior to intervention & (ii) immediately post intervention **Time of Day:** Between 3:30 pm & 8:30 pm	**Acute:** Cortisol levels decreased over the 90-min time interval ($p = 0.004$) **Chronic:** Baseline cortisol levels increase throughout pregnancy

(Butzer et al., 2015)	36 Elementary School Children	**Yoga 4 Classrooms [A]** - Breathing, Postures, Relaxation, Meditation: (i) 2 min centering, (ii) 5 min themed discussion, (iii)3 min breathing exercise, (iv) 15 min postures/exercises, & (v) 5 min relaxation and closing.	Modified for their own physical abilities	**Length of the Study:** 10 weeks	**Acute:** Neither grade showed significant decreases in salivary cortisol from before & after a single yoga class.
				Duration of the Yoga Session: 30 min once per week	
	2nd Graders: (11M, 7F)	**Groups [B]** - 2nd vs 3rd graders		**Cortisol:** Salivary - (i) immediately prior to the Attention Network Test (ATN), (ii) immediately after the ATN, (iii) immediately after a single yoga class	**Chronic:** (A) 2nd & 3rd graders experienced significant decreases in cortisol from before to after a cognitive task & (B) decrease in baseline salivary cortisol levels after 10 weeks in 2nd graders & not 3rd graders
	3rd Graders: (9 M, 9 F)			**Time of Day:** Yoga sessions & Attention Network Tests taught during regular class time	
(Field et al., 2013)	92 Depressed Pregnant Women	**Prenatal Yoga [A]**: Only physical poses listed - spinal twist, table pose, cat/cow, kneeling balance, kneeling warrior, runner's stretch, stork pose, tree pose, eagle pose, warrior 1, warrior 2, reverse warrior, side-angle pose, triangle pose, sitting angular pose, cow's head pose, butterflies and prayer position	Not Specified	**Length of Study:** 12 weeks	**Acute:** Immediate decrease in salivary cortisol from pre-post session in both groups
				Duration of Yoga Session: 20 min posture practice once per week	
	Age 24.9 ± 5.2 yrs	**Control Group [B]**: Social support meetings		**Cortisol:** Salivary pre/post measurements for first & last sessions	**Chronic:** (i) Both groups showed increased baselines of salivary cortisol from the first to the last day of the study & (ii) both groups showed decrease in salivary cortisol from pre-post session at week
				Time of Day: Mid-morning	
(Furtado et al., 2016)	35 Geriatric Women	**Chair Yoga [A]**: Philosophy of Hatha Yoga & its asanas(postures) with focus on flexibility	Intensities reached 50-75% of maximum heart-rate values	**Length of Study:** 14 weeks	**Acute:** Control Group salivary cortisol increased significantly (p = 0.050) & Yoga Group salivary cortisol had no significant changes(p = 0.158)
				Duration of Yoga Session: at least 2 sessions per week (*duration of sessions were not specified)	
	Age 83.81 ± 6.6 yrs	**Control Group [B]**: No intervention	Aimed to achieve moderate intensities in classes	**Cortisol:** Salivary pre/post after first & last sessions	**Chronic:** Yoga Group maintained stress hormone levels vs Control Group
				Time of Day: Same time in the morning	

(García-Sesnich et al., 2017)	26 Volunteers 5 Males & 21 Females Yoga Group Age: 25.1 ± 3.9 yrs Control Group Age: 23.9 ± 2.1 yrs	**Kundalini Yoga [A]**: 5–10 min warmup, 30–45 min kriya, 5–15 min layout, 11–31 min of meditaiton **Control Group [B]:** No yoga intervention	Not Specified	**Length of Study:** 3 months **Duration of Yoga Session:** Two 60-90 min yoga sessions per week **Cortisol:** Salivary pre/post on the first & last class **Time of Day:** Classes held & samples collection between 12:30-4pm	**Acute:** Beginning and end of 3 months had acute decrease of cortisol concentrations from pre to post intevention; (*p*= 0.042 & 0.001, respectively) **Chronic:** No significant differences in cortisol levels in control group (p = 0.53) & yoga group (p = 0.09)
(Gopal et al., 2011)	60 Female Volunteer Medical Students Age Range: 17-20 yrs	**Integrated Yoga [A]:** Yogic Prayer (2 min), Micro exercises (6 min), macro exercises (4 min), *Asana* (12 min), *Pranayama* (4 min), *Dhyana* (5min) **Control Group [B]:** No yoga or stress management	Not Specified	**Length of Study:** 12 weeks **Duration of Yoga Session:** 35 min daily **Cortisol:** Serum cortisol & response to exam stress - Pre/Post Medical Exam **Time of Day:** 8 am	**Acute/Chronic:** Serum Cortisol levels during examination stress in control group was higher (187.16%) and statistically significant (p<0.001) than the yoga group (93.1% increase)
(Ha et al., 2015)	24 Females with Shoulder Pain Yoga Group Age: 22.1 ± 2.9 yrs Control Group Age: 22.6 ± 0.9 yrs	**Yoga-Exercise Group [A]:** (i) Posture focus on improving their strength, flexibility, and balance & (ii) Emphasis on alignment breathing techniques - 5 min warm up, 40 min of exercise, and a 5 min cool-down for a total of 50 min **Control Group [B]:** Non-exercise group	Not Specified	**Length of Study:** 12-week **Duration of Yoga Session:** 50 minute sessions 3x per week **Cortisol:** Serum - prior to exercise, immediately after exercise, and after a 30-min rest **Time of Day:** Not Specified	**Acute:** The control group had higher cortisol levels at all stages (i.e., prior to exercise, immediately after exercise, and after a 30-min rest), while the yoga-exercise group had lower cortisol levels at all stages **Chronic:** Yoga exercise group exhibited a significant decrease in cortisol

(Hopkins et al., 2016)	52 Borderline Obese Females	**Bikram Yoga [A]:** Series of 26 hatha yoga postures, two breathing exercises, and two savasanas (i.e., a resting/relaxation posture)	Hot Room - heated to 104 °F	**Length of Study:** 8 weeks	**Acute:** Lower cortisol reactivity levels at post-treatment than control group (*p* = 0.013)
				Duration of Yoga Session: 90 min. twice per week Salivary Pre/Post	
	Age Range: 25–46 yrs			**Cortisol:** Salivary - 7 measurements - (i & ii) Twice during 1/2 hr baseline period (30 min and 15 min), (iii) onset of stressors (0 min), (iv) during stressors (15 min), (v) at cessation of stressors (30 min), and (vi & vii) during recovery (60 min and 90 min).	**Chronic:** Those randomized to yoga had greater decreases in cortisol reactivity over time (*p* = 0.042)
	* Subjects Controlled for Menstrual Cycles	**Control Group [B]:** Waistlist		**Time of Day:** Between 4:00 - 5:30 pm	
(Raghavendra et al., 2009)	88 Female Breast Cancer Patients	**Yoga Group [A]:** Set of asana, pranayama, meditation, and yogic relaxation techniques with imagery - The yoga intervention consisted of a set of asanas (postures done with awareness), breathing exercises, pranayama (voluntarily regulated nostril breathing), meditation, and yogic relaxation techniques with imagery (mind sound resonance technique and cyclic meditation) & Brief support therapy	Not Specified	**Length of Study:** 6 weeks Duration: 60 min three times per week Cortisol: Salivary at 6 a.m., 9 a.m., & 9 p.m.	**Chronic:** Yoga group has significant decrease in mean salivary cortisol levels at 6 a.m. (*p* = 0.001) and pooled diurnal mean cortsiol levels (*p* = 0.01*)*.
				Duration of Yoga Session: 60 min sessions 3 x per week	
	Yoga Group Age: 46 ± 9.13 yrs	**Control Group [B]:** Brief supportive therapy with education that is routinely offered to patients as a part of their care		**Cortisol:** Salivary - focus on circadian rhythm	
	Control Group Age: 48.45 ± 10.21 yrs			**Time of Day:** 6 a.m., 9 a.m., & 9 p.m.	
(Rocha et al., 2012)	36 Brazilian Army Men	**Yoga & Exercise Group [A]:** Exercise & Yoga Sessions (Description of yoga not specified)	Not Specified	**Length of Study:** 6 months	**Chronic:** After 6 months, the salivary cortisol levels increased in the control group (p<0.01) & decreased in the yoga-group (p<0.001)
				Duration of Yoga/Exercise Session: two 60 min yoga & two exercise sessions per week *VS* four 60 min exercise sessions per week for control group	
	Age Range: 20–40 yrs	**Control Group [B]:** Exercise only		**Cortisol:** Salivary	
				Time of Day: 7 am	

(Thirthalli et al., 2013)	54 Depressive Patients Intervention Groups Age: 54.3 ± 8.6 yrs Control Group Age: 34.0 ± 9.7 yrs	**Yoga Alone Group [A]:** Yoga Description Not Specified **Yoga + Medication Group [B]:** Yoga Description Not Specified + antidepressant medication prescribed to patient **Medication Alone [C]:** Only anti-depressant medication prescribed to patient	Not Specified	**Length of Study:** 12 weeks **Duration of Yoga Session:** 60 min daily for 2 weeks, then individually for the last 10 weeks; totaling 50+ sessions within 12 wks **Cortisol:** Serum - Pre/Post - Beginning and after 3 months **Time of Day:** 8 am	**Chronic:** Patients in the yoga-only group showed highly significant corrleation between the drop in depression scores and drop in serum cortisol levels: [A] Yoga-only group: r=0.59, P=0.008); [B] Medication + Yoga group: r=−0.28, P=0.25; [C] Medication-only group: r=0.39, P=0.13
(Kamei et al., 2000)	8 Volunteers 4 Females & 4 Males Age Not Specified	**Yoga Intervention Description:** 15 min. Asana, 15 min. Pranayama, 20 min. 'Soham' Meditation **Yoga Experienced Group [A]** *VS* **Yoga-Inexperienced Group [B]**	Not Specified	**Length of Study:** One session **Duration of Yoga Session:** 50 min **Cortisol:** Serum - Pre Asana/Post Meditation **Time of Day:** 7 am to 4 pm	**Acute:** During the yoga exercise, mean serum cortisol decreased from 11.69 µg/dl to 9.75 µg/dl ($p < 0.05$). ***The results for both groups showed a slow decrease in plasma cortisol.
(Unger, Busse, & Yim, 2017)	111 Undergradate Students 81% Female & 19% Male Age Range: 18-33 yrs	**Guided Relaxation [A]:** Guided visualization accompanied by slow chime sounds. Visualization described a progressive relaxation **Control Group [B]:** Stress management lecture	N/A	**Length of Study:** One session **Duration of Session:** 35 min **Cortisol:** Salivary Pre & Immediate Post **Time of Day:** Between 11:30 am & 4:00 pm	**Acute:** No significant difference in salivary cortisol levels from pre to post intervention

(Vera et al., 2009)	26 Healthy Adults 19 Females & 9 Males Age Range: 30-50 yrs	Sivanasa Yoga Description - body movements (asana), breathing exercises (pranayama) and meditation are integrated into a single multidimensional practice **Long-Term Yoga Practitioners Group [A]** *VS* **Novice Control Group [B]**	Not Specified	**Length of Study:** n/a **Duration of Yoga Session:** n/a **Cortisol:** Serum (comparison between two groups) **Time of Day:** 9am	**Chronic:** Yoga practitioners had higher cortisol levels in the morning
(West et al., 2004)	69 Healthy College Students 65% Female & 35% Male Mean Age: 19 yrs Age Range: 17-24 yrs	**Hatha Yoga Group [A]:** Description Not Specified **African Dance Group [B]:** Description Not Specified **Control Group [C]:** Biology lecture	Dependent on Intervention	**Length of Study:** One session **Duration of Intervention:** 90 min **Cortisol:** Salivary Pre/Immediate Post **Time of Day:** Between 4-6pm	**Acute:** Salivary cortisol increased significantly for African dance ($p < .0001$), decreased significantly for Hatha yoga ($p = .01$), and remained unchanged for biology ($p = .79$)
(Yoshihara et al., 2014)	24 Healthy Women Age Range: 22-49	**Cyclic Meditation Yoga Description:** Savasana, Tadasana, Centering, Ardhakati Cakrasana, Pada Hastasana, Arda Chakrasana, Savasana, Shashankasana, Ardha Ushtrasana, Savasana, Pranyama, & Meditation	Emphasized practicing slowly with awareness & relaxation	**Length of Study:** 12 weeks **Duration of Yoga Sessions:** At least one 60 min. session per week for 12 weeks & at least twice per week for 30 min. at home **Cortisol:** Urinary **Time of Day:** Between 6:00 - 9:00 am urine collected	**Chronic:** No significant changes were observed in the levels of urinary cortisol after the 12 weeks of yoga training

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