YOGA AND PERCEIVED STRESS

by

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ABSTRACT

Objective: College is a time of stress for attendees. Stress among students is of great public health importance, those who experience high stress loads are subject to adverse academic and mental health outcomes. Research on the general population suggests participation in yoga can help alleviate perceived stress. This research aimed to observe changes in perceived stress in University of Pittsburgh students enrolled in a five week group fitness yoga class.

Methods: Following a case series design, the effects of participation in twice weekly yoga classes were observed in 14 university students. Cohen's Perceived Stress Scale, a measure of the perceived uncontrollability of individuals' lives, was used to measure changes in reported perceived stress in the first, third and fifth weeks of yoga classes.

Results: Nine of the 14 students evaluated exhibited a decrease in perceived stress by the end of the summer session. On average, students perceived their stress to decrease by 1.8 points with a median decrease of 2 PSS points.

Conclusion: The present research observed positive changes in perceived stress in university students participating in a five week yoga course. Considering the public health impact of stress among students, this study be used as a starting point for future studies investigating the effectiveness of yoga participation on perceived stress when compared to a control population.

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PREFACE

My deepest gratitude goes to my committee members, especially my advisor and Chair, Dr. Terry, who continuously encouraged and reassured me throughout the writing process.

1.0 INTRODUCTION

Stress describes the autonomic non-specific response to physical, mental, and perceived demands of the environment placed on the body (Rosch, 1998). The World Health Organization (WHO) estimates stress-related disorders will be a leading cause of disability by the year 2020 (Al-Lamki, 2010; Singh et al., 2013). Chronic exposure to stress can reduce energy levels, contribute to ineffective cognitive processing, weaken immune systems, and lead to manifestation of anxiety, depression and interpersonal problems (Baghurst & Kelley, 2013; Matheny, Aycock, Pugh, Curlette, & Cannella, 1986).

Stress is commonly experienced by college students and can negatively affect their overall health and wellbeing (Baghurst & Kelley, 2013). The transitional nature of college, the pressure to succeed academically, and the adjustment of new social settings are all sources of stress. The interaction and accumulation of these stressors can affect a student's ability to cope (Ross, Niebling, & Heckert, 1999).

Physical activity is an effective way to reduce stress (Baghurst & Kelley, 2013; Davis & Dimidjian, 2012; Nguyen-Michel, Unger, Hamilton, & Spruijt-Metz, 2006). Baghurst and Kelley (2013) found participation in physical activity significantly reduced stress in college students. Their study found physical activity was only marginally less effective than stress management classes and considerably less costly and more practical when applied to a university setting.

The purpose of this research was to investigate the effects of participation in yoga on college students' perceived stress. Monitoring changes in perceived stress during the 2013 summer semesters provided insight on the reported stress levels of students enrolled in Yoga U, a group fitness yoga class taught by the author through the Healthy U group fitness program at the University of Pittsburgh.

The objective of the study was to observe changes in students' perceived stress by recording the reported score of perceived stress at the beginning, midpoint, and final yoga sessions. Perceived stress scales were administered to students in the first, third, and final weeks of group yoga classes. This research will enable future research to investigate the direct effects of yoga participation when compared to a control group. This case study can be used as a starting aid in the understanding of the impact of yoga on students' stress.

The present thesis begins with a background that provides a review of relevant literature followed by the methodology of the research, the results, and finally, a discussion of the findings.

2.0 BACKGROUND

2.1 PERCEIVED STRESS

Stress, a term coined by Hans Selye in 1936 in a letter to the Editor of *Nature*, describes the autonomic non-specific response to physical, mental, and perceived demands of the environment placed on the body (Rosch, 1998). While the source of stress is different for each individual, the body's physiological response to stress is similar in all humans (Rosch, 1998).

It is estimated that 35-50% of disenrollment from college is due to students' lack of coping skills under chronic stress (Mohr et al., 2014). Perceived stress, and the subsequent accumulation of stress, is negatively associated with health related quality of life (Bhandari, 2012). Cohen et al. (1998) report a strong dose-response relationship between psychological stress and the risk of developing a cold, with additional stressful life events causing a greater risk of additional illnesses. Stressful life events such as a loss of job, death of a family member, and pressure in an educational setting have been linked to depressive symptoms, coronary artery disease, cardiovascular disease, and cancer (Cohen, Janicki-Deverts, & Miller, 2007). Behavioral changes due to stress, such as over- or under-eating, smoking, excessive drinking, decrease in exercise and/or poor medical regimen adherence, create clear pathways for the negative effects of stress on the human body.

The toll of stress can also be found within the endocrine system. The hypothalamic-pituitary-adrenal (HPA) axis increases cortisol, an essential endocrine factor in the stress response that regulates anti-inflammatory, metabolic, and gluconeogenesis response (Cohen, Janicki-Deverts, & Miller, 2007; Ruiz & Avant, 2005; Susman et al., 1999). This increase in cortisol can remain raised for extended periods of time in those with chronic stress. Constant elevation of cortisol levels is linked to adverse health effects such as depression, cardiovascular disease, and negatively influencing HIV progression (Aschbacher et al., 2013; Burke, Davis, Otte, & Mohr, 2005; Cohen, Janicki-Deverts, & Miller, 2007; Field, Diego, & Hernandez-Reif, 2010). Newcomer et al. (1999) found that when exposed to high levels of cortisol for several days, healthy individuals experience a decrease in memory performance. In his study on noise induced cortisol increase, Spreng (2000) states high levels of cortisol have well-known adverse health outcomes. These outcomes include immune suppression due to reduction in lymphatic tissue, stress ulcers due to increased secretion of gastric juices, and adverse catabolic effects such as protein degradation and promotion of osteoporosis (Spreng, 2000).

2.1.1 Stress in students

College is a time of stress for many. Students who experience high stress loads are subject to adverse academic outcomes as well as mental and emotional health outcomes such as exhibiting a higher risk for suicidal ideation, hopelessness, increased headaches, anxiety and depression when exposed to increased levels of stress (Deckro et al., 2002; Marshall, Allison, Nykamp, & Lanke, 2008). Stewart-Brown et al. (2000) compared students to the general

population aged 18-34 years and found 13% of the general population decreased time spent on work or other activities due to emotional problems while nearly 40% of students cut down on the amount of time spent on work or activities. Similarly, 21% of the general population did not accomplish as much as they would like due to emotional problems compared to 49% of students. University students, health care students, and health care professionals suffer from higher levels of emotional problems, including stress, than the general population due to the demanding nature of their coursework or career choice. The prevalence of psychological morbidity in college students is reported to be 21.8% (Arslan, Ayranci, Unsal, & Arslantas, 2009). Such psychological morbidities can lead to academic and professional burnout (Marshall et al., 2008).

The Marshall et al. (2008) study highlighted a gap in stress research. The researchers state that the majority of investigations focusing on stress in students have been conducted on medical students, specifically nursing and dental students (Abdulghani, AlKanhal, Mahmoud, Ponnamperuma, & Alfaris, 2011; Al-Dabal, Koura, Rasheed, Al-Sowielem, & Makki, 2010; Bansal, Gupta, Agarwal, & Sharma, 2013; Bond et al., 2013; Singh et al., 2013). It has been noted that medical students exhibit greater stress levels than nonmedical students (Abdulghani et al., 2011; Al-Dabal et al., 2010; Marshall et al., 2008; Singh et al., 2013). Al-Dabal et al. (2010) found that 48.6% of the 319 female medical students surveyed reported frequent stress compared to 38.7% of the 297 non-medical students surveyed. The mental and physical health of medical students and thus the medical professionals they become, plays a key role in patient care. Stress as a student can carry over to stress as an intern, through post-graduation and on

into the career and medical practice of the physician; stressed doctors are usually unable to provide their patients optimal care (Al-Dabal et al., 2010).

Medical students rarely seek help for themselves. Impaired thinking, diminished learning ability, and poor perception of physical health worsen as medical training goes on and likely continues to affect mental health status later on in life (Abdulghani et al., 2011; Tyssen, Vaglum, Grønvold, & Ekeberg, 2001). It is important to note that female students report higher levels of stress than males (Abdulghani et al., 2011; Al-Dabal et al., 2010; Dahlin, Joneborg, & Runeson, 2005; Marshall et al., 2008; O'Dougherty, Hearst, Syed, Kurzer, & Schmitz, 2012; Singh et al., 2013; Tavolacci et al., 2013). Abdulghani et al. (2011) found a higher prevalence of stress in female medical students than in male medical students, 75.7% compared to 57%, respectively. Perceived stress has been reported to be higher in females than males as well. Marshall et al. (2008) found the average Perceived Stress Scale score for females in the study was 28.1 out of 40 while males of the study had an average of 22.4 out of 40.

Self-efficacy is a psychological human factor that centers on an individual's belief that he or she has the ability to influence the events in his or her life. Self-efficacy is a fundamental aspect of a person's motivation, performance accomplishments, and emotional well-being (Bandura, 1994). One of the main ideas behind self-efficacy is that if an individual believes an activity to be too difficult or personally unattainable, he/she is less likely to try such an activity (Bandura, 1994). Physical activity interventions that slowly increase in difficulty in manageable steps help participants cultivate a greater sense of self-efficacy (Davis & Dimidjian, 2012). Self-efficacy is highlighted in Bandura's Social Cognitive Theory (Bandura, 1991), which states that human

behavior is guided by self-influence and contingent on monitoring one's behavior, judging personal standards against the outside environment, and self-regulation (Bandura, 1991).

Perception of stressors and personal state of physical health largely determine an individual's response to stress (Flier, Underhill, & McEwen, 1998). Aldana, Sutton, Jacobson, and Quirk (1996) found perceived life stress correlated with low levels of physical activity while Kobasa, Maddi, Puccetti, and Zola (1985) found fewer symptoms of illness in high-stress individuals who exercised compared to those with similar stress levels who did not exercise. Engaging in physical activity has been shown to improve perceived levels of stress; those with the highest levels of stress showed the most improvement in a two- and four- year follow-up of an exercise program conducted by Rueggeberg, Wrosch, and Miller (2012). Similarly, those with higher exercise frequency demonstrated greater decreases in anxiety and depression regardless of changes in fitness or body weight (King, Taylor, & Haskell, 1993).

2.2 PHYSICAL ACTIVITY

In the *2008 Physical Activity Guidelines for Americans,* the United States Department of Health and Human Services (HHS) defines physical activity as "bodily movement that improves health" (pg 3). Indeed, an abundance of research concludes that physical activity is a necessary part of every healthy lifestyle. Regular exercise provides a wealth of health benefits such as greater cardiovascular fitness, increased muscular strength, and decreased blood pressure (HHS, 2008). Participation in regular physical activities has favorable effects on mental health (Assaf, 2013; O'Dougherty et al., 2012; Penedo & Dahn, 2005; Saeed, Antonacci, & Bloch, 2010; Tavolacci et

al., 2013). Greist et al. (1979) looked at running compared to psychotherapy as treatment for depression in 28 young adults and found running alleviated depression symptoms and was equally as effective as psychotherapy.

Similarly, the lack of physical activity can have negative effects. The 2003-2004 National Health and Nutrition Examination Survey (NHANES) found that men who utilized mental health services were less likely to exercise than men who did not use mental health services. Men who used mental health services were sedentary 40 minutes more per day compared to their counterparts. The NHANES did not find a difference between women who utilized mental health services versus those who did not in terms of their physical activity patterns, but noted both women who used mental health services and women who did not reported lower amounts of physical activity than men who used mental health services.

Similar to the previously mentioned perceived stress in college students, medical students exhibit higher rates of depressive symptoms compared to the general population. Dahlin et al. (2005) found in a study of 309 students, 12.9% of medical students met the criteria for self-rated depression versus 7.8% of the control group. Participation in physical activity has been shown to decrease depression symptoms in children, adolescents, and adults (Davis & Dimidjian, 2012; Helmers, Danoff, Steinert, Leyton, & Young, 1997; HHS, 2008). Physical activity is often recommended to the general population as a way to manage stress (Nguyen-Michel et al., 2006). Not only are depression and perceived stress concurrent, both increase as an individual experiences more and more seemingly stressful life events (O'Dougherty et al., 2012). A few common stressful life events college students are likely to experience include transitions

into to college, increased educational demands, a continuously demanding schedule, and/or the financial burden of attending college (Zheng et al., 2013).

With heavy course loads and demanding hours studying, college students might find little time to focus on personal health much less devote time to an hour of exercise. Around 50% of college students do not exercise, making them a population highly vulnerable to metabolic disease as well as poor mental health (Zheng et al., 2013).

2.1 PREVIOUS STUDIES

2.1.1 Physical activity and mental health

Physical activity has been studied extensively as a treatment for depression and stress with positive results demonstrated for both (Davis & Dimidjian, 2012; HHS, 2008; O'Dougherty et al., 2012; Saeed et al., 2010; Tavolacci et al., 2013). In a meta-analysis, Davis and Dimidjian (2012) investigated the amount of physical activity needed to see a reduction in depression in the general population. The authors report improvement in as little as 10 days (Knubben et al., 2007) with greater frequency of exercise producing greater decrease in depression symptoms. In the review *Health benefits of physical activity: the benefits* Warburton, Nicol, and Bredin (2006) confirmed there is irrefutable evidence for the benefits of physical activity and prevention of chronic diseases including mental health diseases.

2.1.2 Yoga reduces stress

Yoga is a low impact form of physical activity as well as an activity for mental well-being through meditation and self-reflection. Practice of yoga has shown to improve perceptions of stress in the general public (Rao, Varambally, & Gangadhar, 2013). Sharma et al. (2013) found a decrease of five points on Cohen's Perceived Stress Scale in healthcare students aged 18-25 years practicing yoga compared to a one-point decrease in the control group. Practice of yoga has shown to change stress hormone levels for the better and can be used concurrently with or as the sole treatment in mental health interventions (Varambally & Gangadhar, 2012). Yadav, Magan, Mehta, Sharma, and Mahapatra (2012) found positive physiological changes due to yoga participation. The researchers reported a decrease of 20 ng/mL in cortisol and a 0.53 ng/mL increase in β-endorphins after a 10 day yoga-based lifestyle intervention in patients with chronic inflammatory or metabolic diseases.

Practice of yoga not only has been shown to improve stress and depression scores, it also has been reported to reduce somatization symptoms such as unexplained headaches, lower back pain, and chest pain (Yoshihara, Hiramoto, Oka, Kubo, & Sudo, 2014). As mentioned earlier, females tend to report greater stress than males (Abdulghani et al., 2011; Al-Dabal et al., 2010; Dahlin et al., 2005; Kanojia et al., 2013; Marshall et al., 2008; O'Dougherty et al., 2012; Singh et al., 2013; Tavolacci et al., 2013; Yoshihara et al., 2014). Yoga decreases premenstrual and postmenstrual stress, depression, and anxiety significantly in healthy females of childbearing age (Kanojia et al., 2013). Michalsen et al. (2005) investigated the changes of mental stress in women during a three month Iyengar yoga (a branch of Hatha yoga)

intervention. The intervention showed significant improvement in measures of stress; the authors concluded that this branch of Hatha yoga alleviates perceived stress and its related symptoms.

2.2 YOGA

Yoga is a non-invasive, minimal side-effect form of low impact exercise that originated in India (Benson & McCallie, 1979; Feuerstein, 2006; Field, 2011). While the country of origin is known, much is still undiscovered about the early beginnings of yoga (Feuerstein, 2006). Yoga practice seeks to combine mind and body in peaceful unity in order to liberate one from worldly suffering and move beyond the cycle of birth and death (Feuerstein, 2006). Using a series of poses, yoga combines breathing, movement, and muscle control. Deep breathing from the diaphragm increases oxygen flow to the brain while bending, twisting and stretching are thought to massage the internal organs (Field, 2011). With practice, muscles are strengthened and toned while joints become more flexible (Field, 2011).

Bond et al. (2013) investigated the effects of a mind-body intervention on medical students. The researchers found that medical students who participated in mind-body exercises not only decreased their perceived stress but were also more likely to recommend mind-body practices to their patients.

Yoga has been scientifically validated as an effective way to manage stress in the general population (Gupta, Khera, Vempati, Sharma, & Bijlani, 2006; Javnbakht, Hejazi Kenari, & Ghasemi, 2009). Sharma et al. (2013) hypothesize better autonomic tone and improved

cardiovascular fitness reduced stress in their yoga subjects while Jerath, Edry, Barnes, and Jerath (2006) found the rhythmic breathing that accompanies yoga interacts with the nervous system to affect metabolic and autonomic functions. A review by Pilkington, Kirkwood, Rampes, and Richardson (2005) emphasized that while yoga is a feasible treatment for anxiety, depression, and stress, the causal pathway is highly complex and not fully understood.

2.2.1 Hatha Yoga

Hatha yoga is the most well-known branch of yoga and very common in western culture. Hatha yoga focuses on the physical aspect of yoga as a way to strengthen the body and mind (Burley, 2000). Hatha yoga's popularity in the west has, according to critics, removed the mind aspect from yoga practice and focused solely on the physical movement and postures or *asanas* (Burley, 2000). Hatha yoga is more than just a series of *asanas*, however; traditional hatha yoga is a holistic yogic path, including disciplines, *asana*, purification procedures (*shatkriya*), gestures (*mudra*), breathing (*pranayama*), and meditation.

Yoga, Hatha and others, is typically practiced in comfortable nonrestrictive athletic clothing with bare feet on a mat or cushioned surface. Similar to a warm-up before engaging in any physical activity, practice starts off slowly with gentle stretches and deep breathing to awaken the body and mind without causing injury. Next, to engage the muscles and joints and increase heart rate, Sun Salutations are usually performed (Figure 1.)

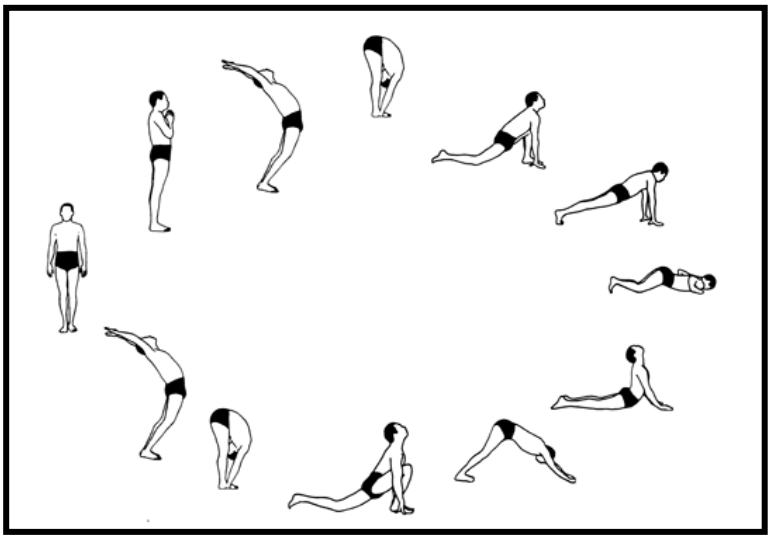

Figure 1. Sun Salutations

Starts in standing or Mountain pose on far left and moves through the circle.
Source: The International Sivananda Yoga Vedanta Centres. (Producer). (2014). Sun salutations [Web Photo]. Retrieved from http://www.sivananda.org/teachings/asana/sun-salutation.html

The work phase follows the Sun Salutations. In Hatha yoga, instructors vary poses and the focus of the work phase from class to class. Figure 2 shows possible poses used in the work phase of Hatha yoga.

Figure 2. Examples of work phase poses

Source: Gandhi, S. (Designer). (2014). Asanas [Web Graphic]. Retrieved from https://sites.google.com/site/8stepstogod/

Finally, to calm the mind and return the heart rate to normal, the class moves into deep stretches and final relaxation. In final relaxation, students are invited to close their eyes and let their minds become completely blank as they enjoy the feeling of stillness and oneness with the body.

3.0 METHODS

3.1 STUDY DESIGN

The present study utilized a case series descriptive design which followed a group of university students over a five week time period. After the five week period, baseline, midpoint, and final Perceived Stress Scale Scores were analyzed for changes. As there was no control group, the students personally overcame or were inhibited by barriers to participation in the twice-weekly yoga class. The weighing of the pros and cons of weekly participation makes this sample representative of the general population who could experience similar barriers to access. The results of the present case series can be used to generate a hypothesis that will be instrumental in designing further studies (Abu-Zidan, Abbas, & Hefny, 2012; Kooistra, Dijkman, Einhorn, & Bhandari, 2009). Case series typically do not follow a specific research design; however, it is recommended that case series contain more than four individuals (Abu-Zidan et al., 2012; Patterson, Weaver, Clark, & Yealy, 2010).

The researcher administered the Perceived Stress Scale to University of Pittsburgh summer students at the first, third, and final weeks of Healthy U's group fitness class, Yoga U. Forty one students enrolled in Yoga U during the two summer semesters and 24 students agreed to participate in the study. Figure 3 presents an overview of participant break down

between the two summer semesters. The present case series aimed to observe the relationship between participation in Yoga U and students' reported perceived stress. Attendance was recorded at each session in order to investigate the possibility that those who attended more classes reported a greater change in perceived stress compared to those who attended less frequently.

3.1.1 Perceived Stress Scale

The study utilized Cohen's Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983) (see Appendix 2) to measure how uncontrollable and unpredictable life events are perceived by the individual. The PSS is made up of 10 general questions that are free of content specific to any sub-population or group. The items are easy to understand and are written in English. Each question is ranked on a 0-4 response scale where 0 = Never, 1 = Almost Never, 2 = Sometimes, 3 = Fairly Often, and 4 = Very Often. Four questions, 4,5,7 and 8, are positively worded and thus are reverse scored (a mark for 0 or Never would receive 4 points whereas a 4 or Very Often would receive 0 points). PSS scores are based on a 0-40 point scale. Higher scores correspond with higher levels of perceived stress.

3.1.2 Yoga U

The University of Pittsburgh offers Yoga U each semester to its students and staff members. Yoga U was taught by the author in the spring semester prior to the present study as well as the

following fall and spring semesters. The University of Pittsburgh requires all fitness instructors to be certified in their appropriate field as well as maintaining up-to-date CPR and AED certifications. The author completed her YogaFit Teacher Training Level 1 in July 2012 and renewed her CPR/AED training in January 2013.

Yoga U was taught in a progressive style that built upon itself from one class to the next. Each pose, such as those in Figure 1 and Figure 2, can be modified into a less or more intensive pose. All three summer classes began with modified poses that are more accessible to the general audience, then the full pose was introduced with the advanced modifications explained after the first few weeks of practice. This structure allows the participants to feel comfortable in pose, thus becoming more self-efficacious, before increasing the intensity of the posture. The comprehensive structure allows participant to move through each yoga pose at his/her own pace. Each class began with a reminder that yoga is a personal journey and listening to the needs of one's body is more important than how advanced a posture is.

3.2 RECRUITMENT

Enrollment in Healthy U Yoga was completely voluntary. Students registered and paid for the class through the University of Pittsburgh's Healthy U Fitness Classes registration. Students did not receive a grade for participation and, while attendance was taken at every session, it was not mandatory to attend every class. Students were approached to participate in the study during the first week of Yoga U classes. Students received the consent form (Appendix A) along with the first Perceived Stress Scale (Appendix B) that was to be used as the baseline test.

Students understood there was no incentive to accept or refuse participation and their choice would not affect their Yoga U experience.

The University of Pittsburgh Institutional Review Board approved this study as exempt in April 2013.

3.3 PARTICIPATION

There were three different classes of University of Pittsburgh students enrolled in Summer Healthy U Yoga classes. Two classes were offered in Summer Session I; one class met every Monday and Wednesday from 12 pm to 1 pm (class AA), and the other met every Monday and Wednesday from 630 pm to 730 pm (class AB) for five weeks from May 13, 2013, to June 17, 2013. Summer Session II offered one Healthy U Yoga class that met every Monday and Wednesday evening from 630 pm to 730 pm (class BB) for five weeks from June 24, 2013, to July 24, 2013.

In the first week of classes students were informed of the opportunity to participate in the Perceived Stress study. Students were given a written document to sign that explained both the study and the Perceived Stress Scale (see Appendix 1). Students were assured that their decision to participate or not would have no effect on their class experience.

A total of 43 students were enrolled in Healthy U Yoga summer classes, 10 students in class AA, seven students in class AB, and 24 students in class BB. Of the 43 students enrolled, 24 agreed to participate with 14 completing at least a baseline and a final PSS.

Classes were held on campus in either William Pitt Union's Dance Studio (class AA) or in Baierl Recreation Center (classes AB and BB). All classes were designed and led by the author. Students were invited to make suggestions on anatomical focus (e.g. shoulders, hips, or backbends) at the beginning of each class.

3.3 ANALYSIS OF DATA

Data were collected, recorded, and reviewed in Microsoft Excel Professional Plus 2013. The mean and median of age of those included, those lost to follow up, answers given for each PSS item, and changes in PSS score were compared.

4.0 RESULTS

Forty one University of Pittsburgh students enrolled in either the first summer semester (classes AA or AB) or the second (class BB) during the summer 2013 term. Seventeen students were enrolled in the first semester and 24 in the second. Ages of the enrolled students ranged from 20 to 42 years old with an average age of 27 years. Two males enrolled in the Healthy U summer sessions, one in class AB and one in class BB.

Twenty four students agreed to participate in the study, detailed in Figure 3. Twenty two of those participants were females. The ages of those who agreed to participate ranged from 20 to 42 years; the average of age participants was slightly higher than those enrolled, 28 years versus 27 years. Ten female students completed only the baseline PSS and were excluded from analysis. The average age of those lost to follow up was 25 years. Three surveys were returned with invalid identification and were not considered part of the 24 consenting participants.

On average, students attended 5.3 of the 10 Yoga U classes during the summer semesters. Students in Class AA attended an average of 4.3 classes, Class AB students attended an average of 5.7 class, and Class BB students attended an average of 5.5 classes. Those who agreed to participate in the study attended more classes than those who did not. Class AA study participants attended an average of 5.6 classes compared to the average of 1.5 classes

attended in non-study participants. Similarly, Class AB study participants attended 7.3 classes in contrast to an average of two classes attended by non-study participants and students in Class BB attended on average of 6.3 classes attended compared to non-participants who attended on average 5.4 classes. Students who demonstrated a decrease in PSS attended more yoga classes than average; 6.4 classes were attended compared to the 5.4 classes attended by all participants.

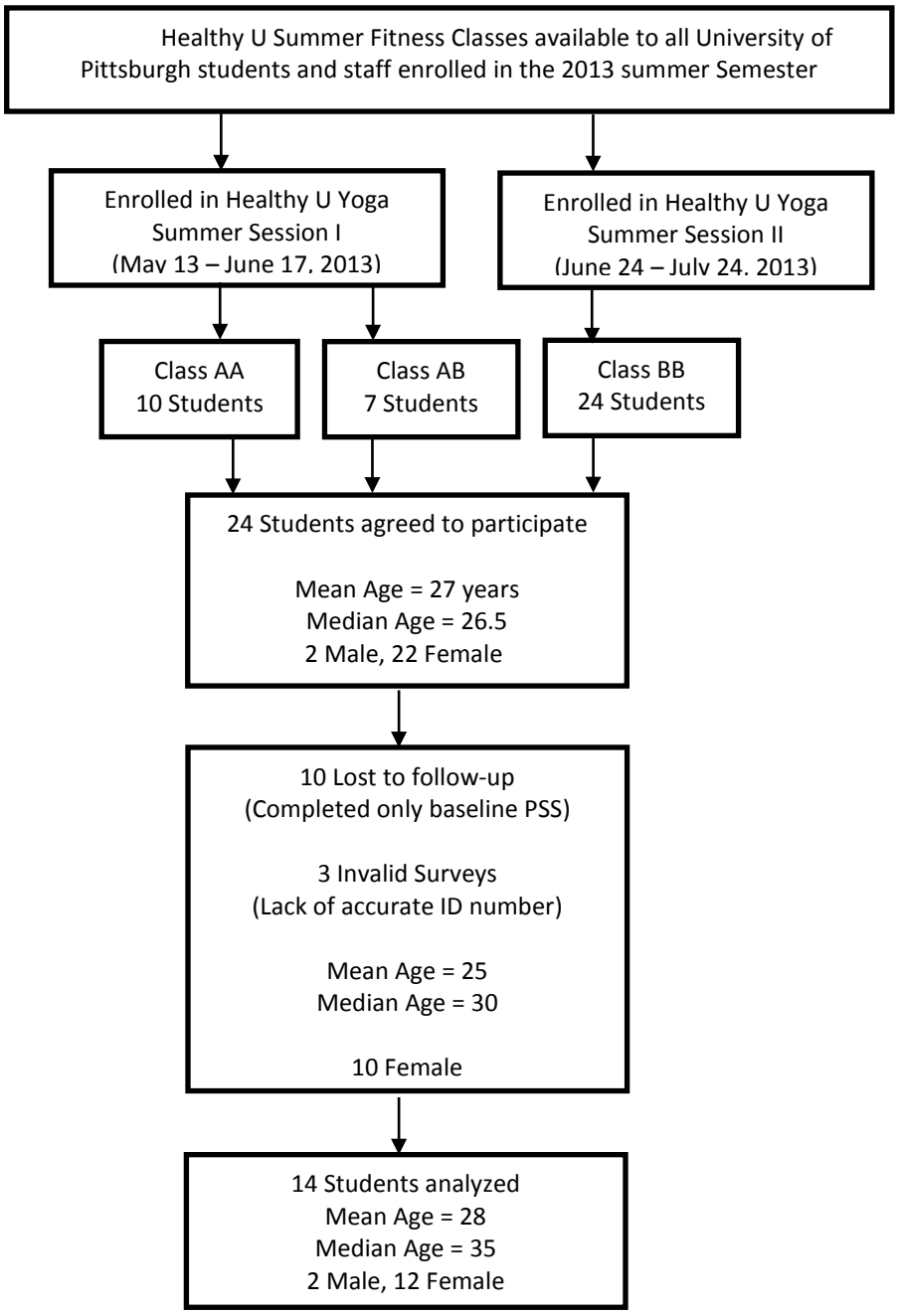

Figure 3. Participation overview

The PSS question order remained the same throughout the study. Questions 4, 5, 7, and 8, the positively worded questions, are highlighted in Tables 1-3 for the purpose of this thesis.

Table 1 shows the baseline, midpoint and final scores for class AA. In the class, 88% of the participants answered 'sometimes' to becoming upset over something that happened unexpectedly. Forty four percent felt they were sometimes unable to control the important things in their lives. Sixty six percent reported feeling nervous and stressed; however, 44% almost never felt they could not cope with everything they had to do. Forty four percent of participants felt confident in their ability to handle their personal problems as well as being able to control irritations in their lives. Sixty six percent were almost never angered by things out of their control, and 44% almost never felt difficulties were piling up so high they could not be overcome.

While nine students completed the baseline survey, only five students completed the midpoint, as seen in the middle column of Table 1, and three students completed the questionnaire at the final class, represented in the last column of Table 1.

Comparing the columns demonstrates a slight shift regarding how participants reacted to something that happened unexpectedly. At midpoint 20% were fairly often upset over unexpected events while the final combined PSS shows 100% were only sometimes upset. Similarly, at midpoint 20% felt they were mostly unable to control the important things in their lives, and at the final administration 66% reported feeling sometimes unable to control important parts of their lives sometimes. Sixty percent reported feeling nervous and stressed at midpoint with a reduction to 33% feeling similarly at the final testing. Twenty percent felt they very often could not cope with everything they had to do at midpoint; at the final testing the

Table 1. Baseline, midpoint, final PSS answers for class AA

	Baseline Test (n=9)					Midpoint Test (n=5)					Final Test (n=3)				
In the last month, how often have you…	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**
been upset because of something that happened unexpectedly?	1		8				2	2	1				3		
felt that you were unable to control the important things in your life?	2	3	4				3	1	1			1	2		
felt nervous and "stressed"?			2	6	1		2		3				2	1	
felt confident about your ability to handle your personal problems?		2		3	4				5			1		2	
felt that things were going your way?		1	3	3	2			2	3				1	1	1
found that you could not cope with all the things that you had to do?		4	3	2			2	2		1		2	1		
been able to control irritations in your life?		2	2	4	1			2	3				1	2	
felt that you were on top of things?		2	4	2	1	1		3	1			1		2	
been angered because of things that were outside of your control?		6	3	1			2	1	2			1	2		
felt difficulties were piling up so high that you could not overcome them?		4	3	2		1	1	2	1			2	1		

66% almost never felt they could not cope with all the things they had to do. Feelings of anger due to circumstances outside one's control and feelings of difficulties piling up shifted from a wide range of answers at midpoint to a small cluster of "almost never" and "sometimes" answers at the final PSS.

Class AB was also held in Summer Session 1 and in the first week of yoga classes (May 13 and May 15) six participants completed baseline Perceived Stress Scales. Table 2 shows the baseline, midpoint and final scores for class AB.

In class AB, 50% of the participants answered 'sometimes' to becoming upset over something that happened unexpectedly. Similarly, fifty percent felt they were never unable to control the important things in their lives, and felt nervous and stressed. Fifty percent of the class almost never felt they could not cope with everything they had to do and felt confident in their ability to handle their personal problems as well as being able to control irritations in their lives. Fifty percent were almost never angered by things out of their control, and 66% almost never or never felt difficulties were piling up so high they could not be overcome.

The middle and final columns of Table 2 reveal a shift in combined answers from the week five midpoint testing to the week 10 final testing, respectively. Class AB's midpoint answers (n=5) ranged the entire spectrum of answers while at the final test (n=3) were more centrally located around the less extreme ends (almost never, sometimes, and fairly often). However, while there were fewer extremes at the final testing, it appears that class AB's perceived stress levels were less than optimal and did not improve greatly even as the class continued. The positively worded questions also did not demonstrate improvement.

Table 2. Baseline, midpoint, final PSS answers for class AB

	Baseline (n=6)					Midpoint (n=5)					Final (n=4)				
In the last month, how often have you…	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**
been upset because of something that happened unexpectedly?	1	1	3		1	1	1	3					3		
felt that you were unable to control the important things in your life?	3	2		1		3		2				1	1	2	
felt nervous and "stressed"?		1	3	2			2	1	2				2	1	1
felt confident about your ability to handle your personal problems?			1	3	2		1		1	3		1	2	1	
felt that things were going your way?			3	2	1			1	3	1			1	3	
found that you could not cope with all the things that you had to do?		3	2	1		2	1	2					2	2	
been able to control irritations in your life?			1	3	2				4	1			3	1	
felt that you were on top of things?		1	1	3				1	4				3	1	
been angered because of things that were outside of your control?	2	3			1	2	2	1				2	2		
felt difficulties were piling up so high that you could not overcome them?	2	2	2			2	1	1	1			2		2	

Class BB was held in Summer Session 2. In the first week of yoga classes (June 24 and June 26) six participants completed baseline Perceived Stress Scales. Table 3 shows the baseline, midpoint and final scores for class BB.

In class BB, there was a wide range of answers at baseline for question one regarding how participants reacted to something that happened unexpectedly; 33% were never or almost never upset, 33% sometimes were and 33% often or fairly often became upset. Fifty percent felt they were mostly unable to control the important things in their lives. Eighty three percent reported feeling nervous and stressed, and 50% felt they often could not cope with everything they had to do. Despite higher scores of perceived stress than the previous two classes, 50% of participants felt confident in their ability to handle their personal problems as well as being able to control irritations in their lives and stay on top of things. Fifty percent were often angered by things out of their control, and 66% sometimes or fairly often felt difficulties were piling up so high they could not be overcome.

Table 3 illustrates class BB's changes between the midpoint examination (middle column) and the final class examination (last column). Three students participated in the midpoint test and two in the final test. Even though the sample size was smaller than the previous two classes, class BB showed signs of decreased perceived stress. At midpoint 100% experienced feeling upset over unexpected events while the final combined PSS shows 50% were only sometimes upset and 50% were never upset over unexpected events. Only 33% felt they were never unable to control the important things in their lives. However, at the final administration 50% reported never feeling unable to control the important aspects of their lives. Sixty six percent reported feeling nervous and stressed at midpoint with a reduction to

Table 3. Baseline, midpoint, final PSS answers for class BB

	Baseline (n=6)					Midpoint (n=3)					Final (n=2)				
In the last month, how often have you…	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**
been upset because of something that happened unexpectedly?	1	1	2	1	1		2	1			1		1		
felt that you were unable to control the important things in your life?		2	1	3		1	2				1		1		
felt nervous and "stressed"?		1		3	2	1		2			1		1		
felt confident about your ability to handle your personal problems?			3	2	1			2		1				1	1
felt that things were going your way?			3	3			1		2				1		1
found that you could not cope with all the things that you had to do?	1		2	2	1	1	1	1			1	1			
been able to control irritations in your life?			3	3			1	1		1			1		1
felt that you were on top of things?			2	3				2	1					1	1
been angered because of things that were outside of your control?		1	2	2	1		2	1			1		1		
felt difficulties were piling up so high that you could not overcome them?		2	2	2		2	1				1	1			

50% feeing similarly at the final testing. Thirty three percent felt they sometimes could not cope with everything they had to do at midpoint; however, at the final testing 100% of participants never or almost never felt they could not cope with tasks they had to do. Feelings of anger due to circumstances outside one's control decreased from 66% almost never experiencing anger to 50% never experiencing anger. Feelings of difficulties piling up remained low at both midpoint and at the final test administration.

The changes for the whole class in PSS from baseline to midpoint and from midpoint to final provides some evidence of yoga's positive effect on perceived stress. However, investigating the changes in PSS scores of each individual presents a stronger case.

Table 4 illustrates a decrease in perceived stress in individuals AA2 and AA6 based on all three of their completed PSS scores. Due to the low number of students completing all three exams, those who took at least two assessments were also considered. AA7 and AA9

Table 4. Changes in individual PSS scores in class AA

	Initial Perceived Stress Score	Midpoint Perceived Stress Score	Final Perceived Stress Score	Total Classes Attended
AA1	13			1
AA2	16	12	12	8
AA3	10			1
AA4	15	16		7
AA5	9			5
AA6	23	26	22	9
AA7	18	12*		5
AA8	21*			1
AA9		20	14	5
AA10	25			1

*PSS was taken at the second class of the appropriate week (class two of week one or class six of week five)

demonstrated a decrease in perceived stress from baseline to midpoint and midpoint to final, respectively. Only one individual, AA4, showed an increase in perceived stress; however, AA4 completed only baseline and midpoint scales. It cannot be determined if AA4 would continue to increase perceived stress or follow AA6's trend with a peak at midpoint but ultimately having a lower PSS score at the final administration.

Table 5 presents Class AB's individual scores. These scores reflect the general increase of perceived stress that the combined data (Table 3) presented. Students AB2 and AB6 showed improvement in perceived stress scores; however, both completed only baseline and midpoint exams. Individuals AB1, AB4, and AB7 scores increased by one point each while AB9 reported a two point increase.

Table 5. Changes in individual PSS scores in class AB

	Initial Perceived Stress Score	Midpoint Perceived Stress Score	Final Perceived Stress Score	Total Classes Attended
AB1	12	17	18	10
AB2	7	4		5
AB3				0
AB4	24	19	25	9
AB5			15	8
AB6	7	3		7
AB7	18		19	8
AB8				0
AB9	10	12		5

Table 6 shows a decrease in perception of stress in 100% of the completed perceived stress scales. Individual BB5 exhibited an eight point decrease in depressive symptoms and was the only student in class BB to participate in all three exams. BB6 and BB16 showed a one point

and a three point decrease in perceived stress, respectively, but completed only two of the three assessments. As with class AA, it cannot be determined if had BB6 and BB16 would have experienced a greater decrease if they had participated in the complete testing.

Table 6. Changes in individual's PSS scores in class BB

	Initial Perceived Stress Score	Midpoint Perceived Stress Score	Final Perceived Stress Score	Total Classes Attended
BB1				4
BB2				6
BB3	18			6
BB4				4
BB5	8	4	0	10
BB6		17*	16	6
BB7				10
BB8				6
BB9				10
BB10				9
BB11				9
BB12				8
BB13	22			3
BB14				3
BB15				5
BB16	19	16		3
BB17				3
BB18				2
BB19	27			5
BB20	20			7
BB21				3
BB22				1
BB23				7
BB24				3

*PSS was taken at the second class of the appropriate week (class six of week five)

5.0 DISCUSSION

Of the students who completed baseline and final PSS scores within the testing period, one student in class AA self- identified as a medical student, and three students in class AB self-identified as a medical student. It is well documented that medical students experience more stress during their schooling career than their non-medical peers (Abdulghani et al., 2011; Al-Dabal et al., 2010; Marshall et al., 2008; Singh et al., 2013). However, as Marshall et al. (2008) pointed out, many studies on stress utilize only medical students as participants. The present study observed a mixture of medical and non-medical students, with 29% identifying as a medical student. There was a higher concentration of medical students participating in the study comparatively as University of Pittsburgh medical students made up 18% student body (Office of Institutional Research, 2013).

On average, students perceived their stress to decrease by 1.8 points with a median decrease of two PSS points. A reduction in perceived stress was observed in nine of the 14 students. Observation of a decrease in stress was found in other studies on adult populations (Bansal et al., 2013; Bond et al., 2013; Field, 2011; Saeed et al., 2010; Zheng et al., 2013).

Those who reported a decrease in perceived stress attended an average of 6.4 classes, one more class than the average yoga student. Class attendance for this population ranged from three to 10 classes with a median of six classes. Of the nine students who reported lower

perceived stress scores, seven were female and two were males. The seven females with decreased perceived stress represent 58% of the female participants studied; the two males with decreased perceived stress represent 100% of the male participants studied. A higher percentage of males reporting a decrease in perceived stress is consistent with the findings of Abdulghani et al. (2011) and Marshall et al. (2008).

Classes AA and BB showed the most improvement in PSS scores. Responses to the negatively worded items (feeling upset over unexpected events, feeling nervous and stressed, feeling angry due to outside circumstances, feelings of inability to cope with everything and feeling like difficulties were piling up) shifted from one side of the answer spectrum to the other; from fairly often or very often to sometimes, almost never, or never.

The reduction of perceived stress reported in over half of the participants could be due to a number of reasons. As reviewed previously, yoga has been scientifically validated as an effective way to manage stress, anxiety, and depression in adults (Gupta et al., 2006; Javnbakht et al., 2009). The physical fitness aspects of yoga such as improvement in autonomic tone and cardiovascular health (Sharma et al., 2013) are hypothesized to help reduce stress. Yoga's use of rhythmic breathing is also hypothesized to decrease stress (Jerath et al., 2006). Khasky and Smith (1999) reported greater states of physical relaxation in the yoga group of their study compared to controls in their study on stress and relaxation states. Relaxation is an important part of every yoga class (indicated in Figure 2 as *Savasana*) and helps achieve a calm mental state (King & Remenyi, 1989). Students' reported decrease in perceived stress could be due to the physical benefits, the practice of breathing purposefully, the mental and physical relaxation, or a combination of these aspects.

The reported decrease in PSS scores could also be due to unknown outside influences. A high exam score, an advancement in employment, or positive family support could have improved students' perceived stress. The present study was held during the beginning of summer; sunshine could have also reduced students' stress.

Class AB showed the least improvement in PSS scores as a whole; two of the six participating students in AB reported a decrease in perceived stress. There are a few possible explanations for the students who reported an increase in their perceived stress. One interpretation is that as participation in yoga may have been a new experience for the individual and to some extent caused a change in weekly schedule, it could have contributed to unnecessary stress due to the new twice weekly hour long time obligation. Had the summer semester continued for longer than five weeks or had the class met less frequently perceived stress may have decreased. New exercise programs have sometimes shown to be a point of stress in individuals just starting a physical activity regimen, especially in females (Johnson-Kozlow, Sallis, & Calfas, 2004; O'Dougherty et al., 2012). Johnson-Kozlow, Sallis, & Calfas (2004) found that males responded positively to physical activity as a way to cope with stress while O'Dougherty et al. (2012) found that female exercisers exhibited increased perceived stress. In the present observations, participants who indicated an increase in perceived stress throughout the course were all females whereas the male participants demonstrated the greatest decreases (by 4 and 8 points) in PSS scores.

A second explanation for the observed increase in perceived stress among a few of the participants could be related to stressors outside of the study's observation. Healthy U summer sessions are aligned with University of Pittsburgh's summer semesters. Due to the shortened

length of summer semesters, classes are often greatly condensed and demanding along with requiring examinations in close succession. There is great variability in what one perceives as stressful; exams and homework could be highly stressful to some while they could be a mere inconvenience or even enjoyable to others. The present study's midpoint and final measurements could have unknowingly aligned with students' summer midterms and final exams. Tavolacci et al. (2013) noted in their study that many students did not return take-home assessments during stressful examination periods.

It is important to note that because there was no control group in the present case series, observations of the changes in PSS scores could be purely coincidental. The increases or decreases in students' perceived stress could have been captured as part of a continuum or a steady change already occurring in the individual's stress. This study can serve as an indication of feasibility for future investigations. The University of Pittsburgh already offers a wide variety of group fitness classes. Future studies can utilize these programs and use a design similar to the present case series as an intervention arm of a study while comparing yoga participants to a control group.

6.0 CONCLUSION

College is a major life change for students and can be both beneficial for and detrimental to various aspects of health. Students can have a difficult time balancing coursework, social activities, and proper health practices. Those who perceive high stress loads experience adverse academic, emotional, and health outcomes. Students can exhibit a higher risk for suicidal ideation, hopelessness, increased headaches, anxiety and depression when exposed to increased levels of stress (Deckro et al., 2002; Marshall et al., 2008). Often, inappropriate and unhealthy coping mechanisms are utilized by students under duress (Al-Sayed et al., 2014; Moore, Burgard, Larson, & Ferm, 2014; Walker & Stephens, 2014). Activities such as sedative drug use (Al-Sayed et al., 2014), psychostimulant abuse (Moore et al., 2014), and binge drinking (Walker & Stephens, 2014) are common coping strategies employed by students.

Physical activity is recommended to the general population as a healthy way to manage stress (Nguyen-Michel et al., 2006). Brown (1992) found physical activity and fitness helps mediate effects of negative stress in college students. The University of Pittsburgh encourages students to participate in physical fitness classes to maintain and improve personal health by offering Healthy U group fitness classes. Healthy U classes are offered when school is in session in safe, controlled environments led by the students' peers. The present study's Yoga U class is one of the group fitness classes offered through Healthy U. Yoga U is taught progressively; that

is, each class builds upon the pervious classes and revisits past focuses. This cumulative technique aims to increase students' self-efficacy by steadily advancing the poses and highlighting personal growth.

Whether yoga is practiced for fitness or for relaxation, practicing yoga for stress release has shown positive results in the general public (Gupta et al., 2006; Javnbakht et al., 2009). The present study provides a starting point for future studies to add to the growing evidence that yoga might be a way to reduce perceived stress in university students. This study observed a reported decrease in perceived stress in nine of 14 participants after five weeks of participation.

After the completion of each summer semester, baseline, midpoint, and final Perceived Stress Scale scores were analyzed for changes. Results indicated that more than half of the participants perceived a decrease in stress. Due to the limited two hours per week exposure to participants, it is difficult to determine how outside influences such as school work, professional work, family life, and personal life influenced each student's perceived stress. The absence of a control groups means no conclusions about yoga participation and perceived stress can be drawn; however, the present case series demonstrates that performing a study on the effects of yoga is feasible in a university setting with similar amenities as the University of Pittsburgh. The observations of the present case series can be used to generate a hypothesis that will be instrumental in designing further studies (Abu-Zidan et al., 2012; Kooistra et al., 2009).

Ages of the 14 participants ranged from 20 to 42 with an average age of 27. The average age of all University of Pittsburgh students was 24 and the average graduate student age was

28 at the time of the study (Office of Institutional Research, 2013). Due to the higher concentration of medical students in this study compared to the University of Pittsburgh population, considering only the average age of university graduate students would show that the present sample might be considered representative of the graduate population. Students were invited to participate in the study with no incentive to accept or refuse participation. Those who accepted the invitation may inherently be different than those who did not in that they may be more willing to try new things or find enjoyment in physical activities, indicating a possibility of volunteer bias in the study subjects. As students were operating voluntarily, the participants were representative of those who overcame the barriers to access a twice-weekly yoga class. Barriers such as upcoming exams, heavy traffic, or increase in academic load can be experienced at any time during the school year.

Reporting bias could have occurred due to the self-report nature of the study and different interpretations of the PSS could cause individuals to answer differently.

The high attrition rate of summer students was one of the study's limitations. Summer is often a time for visiting friends and family vacations. The Fourth of July holiday occurred in the middle of the Summer Session 2, which could account for higher absenteeism. The average number of classes attended in all three sessions was five; however, those who had a decrease in PSS scores attended an average of six classes. Yoga U is offered during fall and spring semesters as a 10 week program; future studies should collect data on students' perceived stress after a longer period of time.

The relatively small sample size was another limitation of the case series. The small sample size aided in reviewing PSS scores and conducting the descriptive research in a short

time period (Hackshaw, 2008). While the present study adheres to Abu-Zidan et al.'s (2012) suggestion of more than four subjects in a case series, interpretation of observed results are very limited. The small number could be due to the financial obligation of participating in Healthy U classes; future studies should recruit a larger number of students perhaps with no financial obligation.

Based on literature for the general population, it is recommended that university officials consider the provision or requirement of a form of physical activity, such as yoga, during the semester for all students as a proactive way to manage stress. Physical activity classes are nearly as effective as psychological skills training in reducing stress (Baghurst & Kelley, 2013). The University of Pittsburgh already employs many extracurricular physical activity classes via Healthy U and expanding the program would not be impossible. Implementing a university wide requirement of one semester of a physical activity course would also be beneficial to students who find tight schedules or lack of funds a barrier to access. Future research endeavors need not be time bound. Yoga U and other Healthy U classes are offered every semester and students can register for group fitness classes as long as they are enrolled or employed at the university.

Despite its limitations, this study provides insight on the feasibility of future investigation of the possible positive effects of yoga on student mental health. Replicating the present study while adding a control group of University of Pittsburgh students would be the next step in investigating the changes of perceived stress in yoga students. A randomized control trial (RCT) would be the most rigorous way to investigate the true effects of yoga on

perceived stress in students. Ideally, a RCT would last the entire school year and would enroll and retain a large number of students in both the control and intervention arms.

The effects of physical activity on reducing stress are clear. Yoga is one form of physical activity that has been proven to help the general population manage stress. As the present study demographics show, individuals of varying ages and abilities can participate in yoga. With health and wellbeing in mind, universities should encourage students to regularly engage in physical activities such as yoga, so that students as a whole are healthier.

APPENDIX A: CONSENT FORM

The purpose of this research is to understand the effects of yoga on perceived stress in college students. College students enrolled in University of Pittsburgh's Yoga U fitness classes will be asked to fill out the brief 10 item Perceived Stress Scale. If you are willing to participate, the questionnaire will ask a few demographic questions (gender, age, and year in school) and then move into the 10 questions about how you have been feeling in the past month. There are no risks associated with participation, there are also no benefits. You will not receive compensation for participation.

This questionnaire is completely anonymous, none of the information provided will be linked back to the individual. All responses are confidential and results of the PSS will be kept in a safe and secure place. Attendance sheet with ID numbers will never be stored with completed PSS questionnaires.

Your participation is completely voluntary and you may withdraw from the study at any time. This study is being conducted by Lea Petersen. Please feel free to reach her at lgp5@pitt.edu should you have any questions.

APPENDIX B: PERCEIVED STRESS SCALE FOR YOGA U PARTICIPANTS

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you felt or thought a certain way.

ID_____ Session # _____

Age _____ Gender (Circle): M F Year in School _____

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly?	0	1	2	3	4
2. In the last month, how often have you felt that you were unable to control the important things in your life?	0	1	2	3	4
3. In the last month, how often have you felt nervous and "stressed"?	0	1	2	3	4
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	0	1	2	3	4
5. In the last month, how often have you felt that things were going your way?	0	1	2	3	4
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	0	1	2	3	4
7. In the last month, how often have you been able to control irritations in your life?	0	1	2	3	4
8. In the last month, how often have you felt that you were on top of things?	0	1	2	3	4
9. In the last month, how often have you been angered because of things that were outside of your control?	0	1	2	3	4
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	0	1	2	3	4

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The PSS Scale is reprinted with permission of the American Sociological Association, from Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. Journal of Health and Social Behavior, 24, 386-396.

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