AN EXAMINATION OF THE EFFECTIVENESS OF AN 8-WEEK BIKRAM YOGA PROGRAM ON MINDFULNESS, PERCEIVED STRESS, AND PHYSICAL FITNESS

by

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AN EXAMINATION OF THE EFFECTIVENESS OF AN 8-WEEK BIKRAM YOGA PROGRAM ON MINDFULNESS, PERCEIVED STRESS, AND PHYSICAL FITNESS

Abstract
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Previous research has examined the effects of yoga on levels of mindfulness. The physical and psychological outcomes of participation in a Bikram yoga program have not been thoroughly researched, yet this type of yoga may be significant with regards to stress management and inactivity due to its unique method of practice. The purpose of this study was to observe the changes in the levels of mindfulness, perceived stress and physical fitness due to participation in an 8-week Bikram yoga program. It was hypothesized that participants would show improvements in mindfulness, perceived stress and physical fitness. Fifty-one males and females between the ages of 20-54 years (M=31.57, SD = 9.287) were recruited from the Boise State University population, and by word of mouth. Participation was limited to those who had engaged in less than two years of long-term practice of Bikram yoga, and who had not attended Bikram yoga in the last three months. Participants attended a minimum of three Bikram yoga sessions per week for 8-weeks. Average attendance was 28.59 sessions (SD = 9.21), which was above the minimum requirement of 24 sessions. Mindfulness was measured pre- and post-intervention using the Five-Facet Mindfulness Questionnaire (Baer, Smith, Hopkins, Krietemeyer & Toney, 2006). Perceived stress was measured using the Perceived Stress Scale (PSS) (Cohen & Williamson, 1988). Components of physical fitness were measured with a 1-mile walk, resting heart rate, a modified sit-and-reach test, a total body rotation test, and a single-leg balance test. A MANOVA showed that participation in an 8-week Bikram yoga program increased levels of overall mindfulness, Hotelling's T = 5.69, $F(4, 47) = 66.8$, $p < .001$, $d = .89$. Paired t tests showed that eight weeks of Bikram yoga lowered levels of perceived stress, $t(50) = 6.19$, $p < .001$, $d = -.79$, did not change resting heart rate, $t(50) = 0.712$, $p = .24$, $d = -.09$, improved predicted VO_2max, $t(50) = 3.73$, $p < .001$, $d = .24$, improved flexibility, $t(50) = 11.48$, $p < .001$, $d = .63$ and improved balance, $t(50) = 4.51$, $p < .001$, $d = .53$. Mindfulness was negatively correlated with perceived stress ($r = -.43$, $p = .002$) and resting heart rate ($r = -.30$, $p = .036$). The results show that Bikram yoga positively affected psychological and physical health in the sample population. This information can be used to further the understanding of mind-body based programs, and how Bikram yoga may give people the tools to decrease perceived stress, potentially having an effect on chronic stress-related illnesses.

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CHAPTER ONE: INTRODUCTION

According to the American Psychological Association (2007), stress-related illnesses continue to cost this nation physically, socially, psychologically, and financially. Many prevalent diseases (e.g., cardiovascular disease) are stress-related and may be largely preventable with proper prevention and intervention strategies that do not require medication. Research designed to assess the prevention and treatment of such illnesses utilizing stress-reduction therapy techniques is a crucial component of the development of effective programs.

Mindfulness is a concept related to being able to be present in a given moment (Kabat-Zinn, 1990). Mindfulness tends to counter the projection of thoughts into the future or back to the past. Such projection may cause stress because such projection increases the uncertainty or regret that might accompany thoughts of the past or future (Salmon, Lush, Jablonski, & Sephton, 2009). Mindfulness is, in fact, thought to be inherent, and that people can develop it with specific training (Bishop et al., 2004; Thera, 1962). Mindfulness is not a recently developed technique; rather, it has been at the center of Buddhist meditative practices for many years (Kabat-Zinn, 2003). As a Western concept, however, it represents a new and different approach to spirituality, and how spirituality relates to the day-to-day processes of life. As technology speeds our world up, it becomes increasingly important to be able to slow oneself down in order to maintain connectivity to natural rhythms using techniques that foster present-moment awareness.

Mastering mindfulness, and the dissociation of oneself from one's reaction to an experience that accompanies it, changes from a reflex-reaction to the experience, to a *reflection* on an experience (Bishop et al., 2004).

Trying to define "mindfulness" is difficult, and there are many interpretations of the concept (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Bishop et al., 2004; Brown & Ryan, 2004; Grossman, 2008; Kabat-Zinn, 1990). Recently mindfulness has been recognized as a multi-faceted concept involving various contributors that influence overall mindfulness (Baer et al., 2006; Bishop et al., 2004; Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008). For the purpose of this paper, mindfulness will be operationally defined as multi-faceted: specifically, attention to and awareness of mind and body, and accepting moment-to-moment experiences without judgment (Kabat-Zinn, 1990).

Mindfulness intervention programs have been used to enhance the feeling of well being and improve psychological function (Carmody & Baer, 2008; Carmody, Baer, Lykins, & Olendzki, 2009), and the use of yoga in such programs is common. Mindfulness is a method of using cognition to alleviate stress. Mind-based stress reduction (MBSR) therapy has been gaining popularity since its Western introduction by Kabat-Zinn in 1990, and developing mindfulness is a main goal of this program. The model proposed by Kabat-Zinn uses three practices: meditation, hatha yoga, and body scan (i.e., sequential recognition of and attention to different body parts) to increase mindfulness and decrease psychological distress. Several studies have documented the success of intervention programs using MBSR therapy, although few have sought to examine each of the three practices and their specific contribution to the effectiveness of

MBSR therapy (Baer et al., 2008; Carmody & Baer, 2008; Carmody et al., 2009; Davidson et al., 2003). Another form of therapy designed to decrease stress, and increase psychological well being is yoga.

Yoga is an ancient Indian practice that couples physical postures with conscious attention to breathing, and a meditative practice. Yoga is used to foster mental and physical awareness, which recognizes the inseparable nature of the two. Yoga literally means "yoke", which accurately describes this mind-body connection, and allows one to overcome the perceived limitations of oneself (Choudhury, 2007; Iyengar, 2001). There are many branches of yoga practice, and hatha yoga, from *ha* meaning sun, and *tha* meaning moon, is the *physical* branch of yoga that unites the mind and the body through the breath, and the use of asanas (postures) (Raub, 2002; Samskrti & Veda, 1977). Yoga is becoming increasingly popular in the Western world, and previous studies have reported that yoga has a positive effect on mood, stress, anxiety, depression, mindfulness, and other quality of life measures (Granath, Ingvarsson, von Thiele, & Lundberg, 2006; Michalsen et al., 2005; Oken et al., 2006; Woolery, Myers, Sternlieb, & Zeltzer, 2004). Yoga is used by practitioners for its meditative qualities, as an effective form of exercise, and as a stress reduction technique; yet limited research is available that has assessed the clinical effects of different styles of yoga on the human mind and body.

Evans, Tsao, Sternlieb, and Zeltzer (2009) present a biopsychosocial model that describes how the asanas, meditation, and breathing of yoga effect the biological, psychological, and social dimensions of health to enhance and balance overall health and function - a goal that is parallel with that of Western medicine. Research has not

described cause-and-effect or correlation between mindfulness and physical fitness; however, mind-based programs such as yoga and Tai Chi Chuan have been shown to improve some components of fitness, including cardiorespiratory health, musculoskeletal health and flexibility as well as psychological health (Hill, Smith, Fearn, Rydberg, & Oliphant, 2007; Hong, Li & Robinson, 2000).

In our increasingly sedentary Westernized world, the yoga component of MBSR therapy programs is of particular interest as it combines meditative practice with physical activity. While research has shown that yoga is effective in increasing balance and strength, it may not be strenuous enough to facilitate cardiovascular improvements by working at the recommended intensity (ACSM, 2006b; Clay, Lloyd, Walker, Sharp & Pankey, 2005).

The development of the MBSR therapy program by Kabat-Zinn (1990) has helped yoga gain credibility as a technique for increasing mindfulness as part of a multi-faceted approach. Yoga practice is unique, as it uses physical asanas to create mindful awareness, and to foster presence in the moment through a connectedness of mind and body. Certain styles of hatha yoga including Iyengar and Kundalini have been tested as intervention and prevention techniques for psychological distress and increasing mindfulness; however Bikram yoga has received little scientific recognition as an effective program for increasing mindfulness and reducing psychological distress (Carmody et al., 2009; Granath et al., 2006; Michalsen et al., 2005; Oken et al., 2006).

Bikram yoga, a form of hatha yoga known colloquially as “hot yoga” is an increasingly popular practice of yoga that has undergone very little scientific examination

since it was founded by Bikram Choudhury, in the United States in 1973 (Choudhury, 2007). Since 1973, 1,700 Bikram Choudhury yoga studios have been opened worldwide, although data on exact participation rates for Bikram yoga could not be found (Choudhury, 2007).

Bikram yoga is a series of 26 asanas including two breathing exercises, and is a unique practice of yoga for several reasons. Bikram is a physically and mentally challenging form of yoga due to the prolonged duration of asanas (i.e., balances held for up to one minute), the 90 minute long class duration, and the intensity of the 105º F heated room. The certified instructor provides continuous feedback to the class, highlighted by constant reminders to keep one's eyes open and focused on oneself in the front mirror in order to foster presence and mindfulness at any given point of an asana. The lights are not turned off for class, and no music is playing during class. These unique environmental factors help to enhance the mindful awareness of the movement of the body at any given moment in time, so that the mind-body connection is anything but elusive.

The physical and psychological outcomes of participation in a Bikram yoga program have not been thoroughly researched, yet may be significant due to its unique method. The few studies conducted report physical improvements that result from a Bikram yoga program, such as, muscular strength, and only one study reported a psychological effect of Bikram yoga (Hart & Tracy, 2008; Lu & Pierre, 2007). Several of the asanas performed in Bikram yoga are the same as the asanas included in Kabat-Zinn's MBSR hatha program as part of the practice of meditation through yoga. Specific

research is needed to further investigate the outcomes of Bikram yoga practice. Researching the effects of the practice of yoga through the scientific method may be difficult because a measurable, uniform prescription of yoga does not compliment the many different ways yoga is practiced (Salmon et al., 2009). Salmon and collegues reported that previous yoga studies were not easily replicated due to the lack of detailed description of asanas used in the study.

Bikram yoga allows for maximum attention to the day-to-day differences in the mind and body because it is a uniform and repetitive form of yoga practice that incorporates the exact sequence and duration of asanas regardless of class time, instructor, or studio location. To a certain degree, this consistent approach controls many variables, leaving each individual and how he or she perceives their body on a given day as the variable that can be manipulated using the asanas. In addition, the dialogue delivered by each instructor is scripted and consistent. Again, this consistency of instruction gives strength and significance to Bikram research, as its commonality across studios allows certain variables to be controlled and may allow for a certain degree of generalization of the results. (See Appendix A for a diagram of the sequence of postures.)

The physical challenge of Bikram yoga lends thought to the difference, if any, in levels of mindfulness and perceived stress when compared to other types of yoga. It has not been reported whether or not a more physical style of yoga, such as Bikram, fosters greater mindfulness and decreased perceived stress due to improvements in the different components of physical fitness. Improved cardiovascular endurance, flexibility, balance, muscular strength and endurance, and body composition may each be correlated with

increases in mindfulness and decreases in perceived stress, but this mind-body connection has never been examined.

In light of its increasing popularity, and the limited research on Bikram yoga as an effective yoga practice, there is great potential for scientific discovery. Participation in a Bikram yoga program may cultivate mindfulness through acute attention to mind-body connectedness, and it may improve one or more dimensions of physical fitness. Research with regards to psychological and physical outcome measures may reveal another effective mind-based program that uses yoga to increase mindfulness, decrease perceived stress, and improve components of physical fitness.

Operational Definitions

Asana

Defined as a physical posture. A yoga session is composed of various standing, seated, and lying asanas; Bikram yoga is a series of 26 asanas.

Bikram Yoga

A specific series of yoga asanas assembled by Bikram Choudhury (2007). A Bikram session is comprised of series is 26 postures including two breathing exercises, takes 90 minutes to complete, and takes place in a temperature-controlled room (approximately 105 degrees Fahrenheit, 40% humidity).

Mindfulness

Defined as attention to and awareness of mind and body, and accepting moment-to-moment experiences without judgment (Kabat-Zinn, 1990). Defined in this study as

sensing and observing thoughts, feelings, and situations around us without attaching preconceived meaning to such observations.

Perceived Stress

Defined in this study as a "the inability to cope with a perceived (real or imagined) threatto one's mental, physical, emotional, and spiritual wellbeing which results in a series of physiological responses and adaptations" (Seaward, 1994, p.7).

Physical Fitness

Defined in this study as the participants' level of health in five areas of physical fitness including: resting heart rate, recovery heart rate and time after walking a mile, ability to stretch the hamstrings and rotate the upper body and hips, and the ability to balance on one leg.

Sanskrit

The classical language of India and Hinduism.

Yoga

Literally means 'to yoke', to join mind and body. Yoga is an ancient Indian practice that couples physical postures with conscious attention to breathing, and meditative practice.

Purposes of This Study

The purposes of this study were to implement an eight-week Bikram yoga program to assess: (a) the pre- and post-intervention differences in participants' mindfulness scores; (b) the pre- and post-intervention differences in participants' perceived stress scores; (c) the pre- and post-intervention differences in participants'

physical fitness levels as measured by resting heart rate, cardiorespiratory endurance, flexibility, and balance; and, (d) to determine any correlation between changes in levels of mindfulness and changes in perceived stress, or changes in physical fitness.

Research Hypotheses

There is no previous scientific research addressing the effects of a Bikram yoga program on mindfulness or perceived stress, however, previous research with other forms of yoga lead to the hypotheses that (a) Bikram yoga will improve mindfulness in participants after 8 weeks and (b) Bikram yoga will decrease perceived stress. Limited research has shown that Bikram yoga elicits improvements in balance and leg strength and steadiness, therefore it was hypothesized that (c) participants will show an improvement in balance after participation in an 8-week Bikram yoga program. No research has shown that Bikram yoga improves cardiorespiratory health, yet people report having an elevated heart rate throughout the yoga session. It was therefore hypothesized that (d), resting heart rate will be decreased, and (e) cardiorespiratory endurance will improve after participation in an 8-week Bikram yoga program. Flexibility has been shown to increase after participation in yoga, and Bikram yoga focuses on hamstring and trunk range of motion. Therefore, it was hypothesized that (f) there will be an increase in trunk and hamstring flexibility. Previous research has not closely examined the correlation between psychological and physical health. Therefore, it was hypothesized that there will be negative correlations between intervention-related changes in mindfulness and (i) perceived stress and (ii) resting heart rate, and positive correlations

between intervention-related changes in mindfulness and (iii) cardiorespiratory endurance, (iv) balance, and (v) flexibility.

Significance of the Study

Stress management techniques are needed more now than ever as the trend of stress-related illnesses, such as cardiovascular disease and depression, continue to cost Western societies psychologically, physically, and financially (American Psychological Association, 2007). Illness related to inactivity is also prevalent in Western cultures, and the mind-body relationship is inseparable. Previous research has neglected to measure the psychological effects *and* the physical effects of mind-based stress reduction programs within the same study. It is the mind-body connection we seek to examine and understand, so it may be beneficial to examine the integrated effect of the mind-body relationship on both the physical and mental components of the mind within the same study.

The significance of the mind-body connection and how it affects mindfulness has been addressed in many studies already, yet there has been little research on the effectiveness of a more physically and mentally challenging program such as Bikram yoga (Baer et al., 2008; Carmody & Baer, 2008; Carmody et al., 2009; Davidson et al., 2003). An intervention program that addresses psychological and physical needs in unison may lead to further developments in mindfulness research, helping to implement prevention and intervention strategies to reduce the occurrence of stress-related illnesses and inactivity.

Assumptions

There were two main assumptions made throughout the duration of this study. First, it was assumed that the temperature of the Bikram yoga studio would remain somewhat constant at approximately 105º F and 40% humidity. It was also assumed that participants would not change their current physical activity levels outside of Bikram yoga over the course of the 8-week program.

Study Limitations

In order to use the Bikram Boise studio for the 8-week period there was a $20 flat fee associated with participation in this study. This fee was not covered by the University, and was voluntarily provided by participants. The fee had the potential to negatively affect subject recruitment, and limit sample size. This participation fee also likely excluded certain people from the study who could not afford to participate, which may have resulted in the recruitment of a certain socioeconomic class that is not representative of the general population.

Inclusion criteria required that participants be able to attend class at the studio ideally five times per week, but at least three times per week for eight weeks. Classes were 90 minutes in duration, and were offered at only one studio in Boise, which may have limited accessibility, and affected subject recruitment.

Bikram yoga is performed in a specially controlled environment that keeps the temperature at or around 105º F and the humidity at or around 40%. This environment is hard to replicate for personal use outside of the studio, which means there is a threat to external validity of the study when applying results to mindfulness outside of Bikram

yoga. Also, the heat and humidity may have discouraged some participants from attending class.

A limitation in the design of the study was the absence of a control group. The research describing Bikram yoga is so sparse that there has been no comparison drawn between Bikram yoga and traditional forms of exercise that are thought to elicit changes in fitness and psychological well being. Once baseline information regarding the effects of a 90 minute long class performed 3-5 times per week is established, research that compares a Bikram yoga program to a traditional exercise program will be merited. This research project can be used to generate power and effect sizes to effectively plan sample sizes for future studies.

The field tests chosen to measure physical fitness may not be as accurate as lab-based tests to measure changes in physical fitness due to involvement in a Bikram yoga training program. The effects of Bikram yoga are, for the most part, scientifically unknown, and so most of the field tests were chosen using face validity to measure hypothesized changes, not because of their use in previous Bikram yoga studies.

The undefined age range also may be a study limitation. Physical adaptations may differ across age groups, which might skew the data because the recruited population covers a large age span.

CHAPTER TWO: LITERATURE REVIEW

Introduction

The purpose of the first section of this literature review is to define mindfulness, report the changes in mindfulness discovered by previous studies, and to report how mindfulness has been measured in previous studies. Effective measures of perceived stress are also evaluated in this section. This first section also includes a brief review on qualitative methods used in behavioral research, in order to understand the most effective way to measure mindfulness. The second part of the literature review discusses mind-based yoga programs, including a discussion of previous Bikram yoga research – in its limited entirety. The focus of the third section of the review is to report on the validity and appropriateness of the chosen measures of physical fitness that were used to assess participants. Lastly, the literature review serves to develop an understanding of the current thoughts on mindfulness, and to assert the possible significance of Bikram yoga as an effective technique for fostering mindfulness, decreasing perceived stress, and improving physical fitness.

Defining Mindfulness and Measures of Mindfulness

Mindfulness, loosely defined as present-moment attention and awareness, continues to gain interest in the field of psychology (Christopher, Charoensuk, Gilbert, Neary & Pearce, 2009). “Mindfulness” is a concept that is fairly new to Westernized societies, and this may affect our understanding of how to measure mindfulness.

Grossman (2008) states that by trying to measure and define mindfulness, we may actually "trivialize the concept and substantially alter its original meaning". Nonetheless, for the purpose of scientific research, it is necessary to define mindfulness in order to facilitate a level of cohesiveness between studies.

Interest in mindfulness is increasing, although it is quite recent, and therefore has only recently required an operational definition for use amongst researchers (Bishop et al., 2004). Most literature reports that mindfulness is a multi-component construct (Bishop et al., 2004; Grossman, 2008; Kabat-Zinn, 1990). A commonality between several research papers is the inclusion of two specific components of mindfulness: attention and awareness (Bishop et al., 2004; Cardaciatto, et al., 2008; Kabat-Zinn, 1990). The product of practicing these two techniques allows for maximal focus and acceptance on an object or an experience, as if it is being perceived for the first time (Bishop et al., 2004). A client practicing mindfulness is encouraged to acknowledge all thoughts that arise in the mind, and then direct the mind back to a specific focus (Kabat-Zinn, 1990). This practice allows the client to *sense* and *feel* without reaction and judgment - which is a valued outcome of practicing mindfulness (Kabat-Zinn, 1990).

Several researchers and practitioners believe that mindfulness is an innate quality that can be cultivated through meditative practices (Bishop et al., 2004; Kabat-Zinn, 1990). Kabat-Zinn (1990) reports that those practicing mindfulness for the first time take to the process quickly, as though they already have the foundations for present-moment awareness; mindfulness is common to all of us (Thera, 1962).

Methods of measuring mindfulness are still being developed and validated as research into the area deepens. Several questionnaires have been developed in the attempt to measure changes in mindfulness, and as previously mentioned, these questionnaires are based on the authors' particular interpretation and definition of the concept of mindfulness. Some questionnaires define scores that describe mindfulness as a single-component construct, when in fact the idea that mindfulness is a multi-faceted construct is becoming increasingly popular (Baer et al., 2004; Baer et al., 2006; Baer et al., 2008; Brown & Ryan, 2003; Cardaciotto et al., 2008). Baer, Smith, & Allen (2004) developed the Kentucky Inventory of Mindfulness Skills (KIMS), which was then used as a guide to develop the Five-Faceted Mindfulness Questionnaire (FFMQ). Thus far, only these two self-report measures define mindfulness as a multi-faceted construct as opposed to a single-component construct (Baer et al., 2004; Baer et al., 2006; Baer et al., 2008; Cardaciotto et al., 2008).

The FFMQ has adequate to good internal consistency and construct validity (Baer et al., 2008). Test-retest reliability has not been tested for the FFMQ, but Baer et al. (2008) used samples of meditators and non-meditators from different educational backgrounds to measure the construct validity of the FFMQ, and analyses of validity were done using intercorrelations. Some have argued that a five-faceted approach may not be necessary when assessing mindfulness and its two key components, attention and awareness, but more research is needed in this area (Cardaciotto et al., 2008).

The Philadelphia Mindfulness Scale (PHLMS) strives to re-evaluate the multi-faceted KIMS and FFMQ and uses a bi-faceted construct upon which to base the PHLMS

questionnaire (Cardaciotto et al., 2008). Cardaciotto et al. (2008) state that a possible weakness of the FFMQ is in the possible overlap of five facets with each other. The PHLMS is a relatively new questionnaire with limited use in current research to date, but it deserves further validation and reliability analysis as an effective tool for measuring mindfulness.

The target users of a given questionnaire are also important to consider when choosing an appropriate measure of mindfulness. The Freiburg Mindfulness Inventory (FMI) scale is designed for experienced meditators, whereas there is no discrimination between meditators and non-meditators when using the KIMS, FFMQ, Mindfulness Questionnaire (MQ), Cognitive and Affective Mindfulness Scale (CAMS), or Mindful Attention Awareness Scale (MAAS), although as expected, meditators tend to score higher than non-meditators on these measures (Baer et al., 2006). These methods of quantitative measurement can be complimented by qualitative research to better understand and measure changes in mindfulness.

Evans et al. (2009) propose that the effects of yoga fall into three categories, physical, psychological, and social, to form a biopsychosocial effect on health and well being. Physical attributes can be quantitatively measured, however it is sometimes difficult to measure psychological and social well being in a quantitative fashion, especially for a multi-dimensional, little-explored construct such as mindfulness. Therefore it may be necessary to measure the effects of yoga using quantitative *and* qualitative methods. A scientific model that measures the three components of yoga described by Evans et al. may represent a valid approach to measuring changes in

mindfulness, and correlations between mindfulness and physical fitness (Christopher et al., 2009). The development of mindfulness assessment tools is in its infancy, and there is a challenge in conceptualizing and measuring mindfulness using Western-based psychology when mindfulness originates from a non-Western context (Christopher et al., 2009). A mixed-methods approach is likely necessary to successfully measure mindfulness and the effects of its practice.

No study has examined the change in mindfulness, or the effects on cardiorespiratory health, and flexibility, after participation in a Bikram yoga program, yet many Bikram yogis have given oral or written testimonials that describe the profound effect of Bikram yoga on their lives. Such testimonials merit future attention because there is a disconnect between the Western approach to scientific research and the Eastern concept of mindfulness that is being measured. The disconnect begs the question, "Can we define and measure the state of spiritual and physical balance and awareness in any given individual being?" Although a mixed-methods approach may be the most effective process to study mindfulness and the mind-body connection, this study will use only a quantitative approach in an attempt to learn more about the potential benefits of Bikram yoga.

Mindfulness research is still a new field, and the assessment tools for measuring mindfulness are even newer. It is expected that with increased clarity of the operational definition of mindfulness, self-report measures of mindfulness will increase in internal and external validity. Taking into account that the definition and measurement of mindfulness currently warrants further investigation, and that we are observing the

previously unmeasured Eastern construct that is mindfulness, the FFMQ is the chosen self-report measure of mindfulness for the current study based on its use and assessment of reliability and validity in previous literature (Baer et al., 2006; Baer el al., 2008; Carmody et al., 2009; Carmody & Baer, 2008; Dittman & Freedman, 2009). The FFMQ can be used with both experienced and inexperienced meditators. Scores on the questionnaire will represent different facets of mindfulness rather than treating mindfulness as a unidimensional concept. This allows for a better understanding of each component of mindfulness.

Perceived Stress

Perceived stress can initiate or elevate the body's natural physiological response to a stressor, whether the stressor is physical, mental, or emotional. Remaining in the elevated physiological response can cause harm to the body, and it is desirable to always return to homeostasis after the response to a stressful situation, or to avoid the response all together. How an individual perceives stressful events in his or her life, and whether or not they feel as though they exert any control over such events, can drastically affect the stress response positively or negatively. Physical and psychological problems can arise, and can often become chronic when the stress response occurs frequently, and the body fails to return to homeostasis.

Many intervention techniques have been developed in order to ameliorate the effects of stress without medication, and whether these effects are initiated physically or psychologically (i.e., exercise or mind-based stress-reduction training) they focus on reducing the effects of the physiological response that occurs in the body when faced

with a stressor. Improved levels of mindfulness and physical fitness as a result of participation in Bikram yoga may serve as mediators that decrease levels of stress, which is why perceived stress was chosen for measurement and analysis in this current study. Any correlations between increased mindfulness and physical fitness would warrant further attention to these potential mediators in future studies using additional statistical analysis.

Some form of the Perceived Stress Scale (PSS) has been used in previous studies examining the effects of mind-based intervention programs, including yoga programs, on stress (Carmody & Baer, 2008; Carmody et al., 2009; Granath et al., 2006). The questionnaire started as a 14-item measure, and reliability ($r = 0.89$) has been determined for a 10-item version as a measure of global stress (Roberti, Harrington, & Storch, 2006). Internal reliability of the 10-item PSS is reported at .78, indicating that it is as good as a measure of perceived stress as its 14-item scale predecessor (Cohen & Williamson, 1988).

The 10-item PSS is a questionnaire designed for use with people who have a minimum junior high school education, which increases the likelihood that it is an appropriate scale for the current study's sample population (Cohen, Kamarck, & Mermelstein, 1983; Cohen & Williamson, 1988). The PSS poses general questions that allow users to respond according to their personal stressors, rather than to predetermined stressors incorporated into the questions. This results in a 'global' measurement of stress, which is beneficial to the nondescript, general sample in the current study. A Likert-scale is used to tally responses to each question, and the questions are designed to measure the

extent to which events in one's life are perceived as stressful. Scores range from zero to 40 with higher scores indicating higher levels of perceived stress.

Mind-Based Yoga Programs

Many believe that Jon Kabat-Zinn formally initiated the popularity and acceptance of using mind-based programs in Western medicine in 1990, which makes the field less than 20 years old in Western societies (Bishop et al., 2004; Cardaciotto et al., 2008; Carmody et al., 2009; Kabat-Zinn, 1990). Mind-based stress reduction programs employ a humanistic approach to psychology by considering free will and volition of the participant as well as ones surroundings. Salmon et al. (2009) notes that the emphasis on the cognitive components of behavior supported by Freud may contribute to the lack of scientific support for (a) the influence of physical movement on behavior, and (b) the inseparable combination of these cognitive and physical components on behavior. Behavior is defined as a product of cognition, whereas mind-based techniques, such as yoga, couple cognition and movement to perceive, understand, and change behavior. Fostered through meditation, mindfulness is an innate state of mind, and has been practiced in Eastern cultures for thousands of years. The value of such a state of mind is becoming more recognized and appreciated in Western culture (Bishop et al., 2004; Christopher et al., 2009; Thera, 1962).

Introducing mindfulness and its effects is commonly conducted through scientifically developed programs that can include meditation practice, yoga practice, and body scan practice (Carmody & Baer, 2008; Carmody et al., 2009; Davidson et al., 2003; Kabat-Zinn, 1990). Most notable is the MBSR therapy program developed by Kabat-Zinn

(1990). This program was developed out of the University of Massachusetts Medical Center and uses body scan, sitting meditation, and hatha yoga to elicit changes in mindfulness, as it is understood and measured in Western culture. The hatha yoga component will be the main focus of this section of the literature review seeing as this study will examine the effects of Bikram yoga, a style of hatha yoga, on mindfulness.

Kabat-Zinn's book, *Full Catastrophe Living* (1990) and a review by Salmon et al. (2009) on the hatha yoga component of the MBSR program describe the role of yoga in fostering mindfulness. The yoga component of the program consists of forward bends, backwards bends, lateral bends, side twists, and spine lengthening poses that are arranged into two different sequences that take 45 minutes each to complete. Participants are encouraged to practice outside of class for 45 minutes each day. Participants are also encouraged to work within a personal zone that challenges them beyond their normal capacity, but not beyond their limits. As the participants move through the series of different asanas, they are changing their inner focus with the physical changes of the body, which is a true connection between mind and body.

Another focus of Kabat-Zinn's MBSR program is focusing on the breath. The Bikram yoga sequence starts and finishes with two different breathing exercises. The purpose of the first exercise is to expand the capacity of the lungs so that they are more efficient throughout the rest of the series. Kabat-Zinn explains that the breath never leaves the body, and therefore is a constant, reliable focus to which we can return when our attention is distracted. The breath allows us to make a cognitive and tangible connection to the body as a vibrant, *living* being. Awareness of the breath entering and

leaving the lungs, and attention to how it changes with the states of one's mind, cultivates a sense of control and power over the mind, and even the physiological response of the body. The breath helps us to stay present and controlled, reducing anxiety that can arise from concentrating on past or future events.

Briefly describing the yoga component of Kabat-Zinn's MBSR program illustrates several commonalities between the MBSR program's practice of yoga, and Bikram Choudhury's practice of yoga.

Bikram Yoga

Yoga is the focus of mind and body on personal development with regards only to oneself. This focus is thought to cultivate qualities that other forms of exercise do not: acceptance and mindful awareness (Evans et al., 2009). Scientific research on Bikram yoga, whether it is of a physical or psychological nature, is extremely limited despite Bikram yoga's growing popularity as represented by the growing number of studios, which is currently at approximately 1700 worldwide (Choudhury, 2007). Bikram yoga, like any yoga, is a meditative practice using physical asanas to create a state of meditative awareness and connection between mind and body. Bikram yoga differs from other types of yoga and meditation in that it is extremely physically demanding, and meditation is fostered in a "switched on" environment, similar to the environment in which we exist on a daily basis. Choudhury gives an example of imagining oneself in bad traffic, needing desperately to use the bathroom and having no air conditioning in your car when a van cuts you off, pulling into your lane; he goes on to say that "if you can find peace under those conditions, then you can meditate anywhere" (p. 76).

Just as there have been few studies examining the positive effects of Bikram yoga on health, there have been few reports of the potential negative impact of yoga on health. A short letter to the editor of the *American Journal of Psychiatry* explains a psychotic episode that occurred after participation in a Bikram yoga class during teacher training (Lu & Pierre, 2007). Lu and Pierre describe a man who had previously reported hallucinogen-induced psychosis, had little sleep leading up to the Bikram-associated episode, was dehydrated, and had been eating poorly. These factors point to the fact that Bikram yoga was clearly not the sole cause of the psychotic episode, and that Bikram yoga may be an unsuitable form of exercise and meditation for people prone to psychotic disorders (Lu & Pierre, 2007). The occurrence of such an event also lends light to the very essence of meditation as it is fostered through Bikram yoga. Bikram does not instruct one to abandon their weaknesses to find strength, rather to detach oneself from external experience, and look within (Choudhury, 2007). As you watch your body move in the mirror in front of you, as you hear the instructor guide and encourage you, and as you accept yourself as you are in that given moment, you expose the weaknesses of your mind and of your body without slipping from a state of attention and awareness. This subject who experienced a psychotic episode after a Bikram class likely had not fueled and rested his body prior to class, and he likely experienced a meditative state that caused him to expose a serious disease of the mind.

A study was conducted by Hart and Tracy (2008) to determine changes in physical fitness after participation in 24 sessions of Bikram yoga over an 8-week period. Specifically, Hart and Tracy were measuring changes in isometric, concentric, and

eccentric strength, steadiness, and balance. In the yoga group, knee extensor isometric strength improved, steadiness improved, especially in those who were less steady to start with, and balance improved significantly (Hart & Tracy, 2008). Hart and Tracy suggested that increases in steadiness might have resulted from a decrease in sympathetic nervous system activity that is thought to accompany yoga practice.

The review of Bikram yoga specific research illustrates the need to develop a method of testing expected yoga-specific outcomes. The following section of the literature review examines various measures of physical fitness and how they relate to the asanas used in the Bikram yoga sequence.

Measures of Physical Fitness

Part of the purpose of this study was to ascertain whether or not changes in physical fitness are seen after participation in 8-weeks of Bikram yoga, which is a mind-based form of exercise. Physical fitness will be defined as measures of cardiorespiratory health, balance, and flexibility. These components of fitness were measured before and after the completion of the 8-week Bikram program. Due to the plethora of different physical fitness measurement techniques, it was necessary to determine appropriate measures for the specific content and participants of this study.

Cardiorespiratory Health

It is unknown how Bikram yoga affects cardiorespiratory health. A previous study by Clay et al. (2005) showed that regular hatha yoga did not elicit a workload comparable to ACSM's standards for improving cardiorespiratory health. However, the duration and intensity of Bikram yoga may improve cardiorespiratory function. In order to measure

cardiorespiratory health and endurance, two measures will be observed. It is well known that a potential chronic adaptation of cardiorespiratory exercise is a lowered resting heart rate (ACSM, 2006a). Therefore, resting heart rate was measured pre- and post-intervention as an indicator of cardiorespiratory health. After resting in a supine position for 5 minutes, participants' pulse was measured for 30 seconds using the radial artery. The measured value was multiplied by two so that heart rate was reported in beats per minute.

Although true maximal oxygen uptake tests are the most accurate tests of aerobic endurance (ACSM, 2006b), they are time-consuming and expensive to administer. In addition, trained technicians must collect data using sophisticated equipment. Several field tests have been developed as a way to predict maximal oxygen uptake based on time to run or walk a certain distance and heart rate at the completion of the test. The 1.5-mile run is a widely used test that allows maximal oxygen uptake to be accurately predicted when compared with a monitored, graded exercise test (ACSM, 2006b; Larsen et al., 2002). It is easy to administer the 1.5-mile run to a large group of people at the same time, without compromising the accuracy of results. However, it is not recommended that the 1.5-mile run be used as a measurement tool in a sedentary population (ACSM, 2006b; Larsen et al., 2002). Current participation in activity and minimal fitness levels are not inclusion criteria for participation in the study, thus, there were sedentary participants. Therefore, a 1-mile walk was a more appropriate measure for the current study's participants. The Rockport One-Mile Fitness Walking Test has become a popular method for predicting maximal oxygen uptake (ACSM, 2006b). The original regression equation

was developed based on males and females aged between 30-69 years. Kline et al. (1987) validated this equation, and predicted values correlated with actual maximal oxygen uptake values (r = .74 to .93). However, this equation may be invalid for college-aged males and females (Dolgener, Hensley, Marsh, & Fjelstul, 1994). Validation of the Kline et al. equation (Dolgener et al., 1994) within a sample of college-aged males and females showed that actual maximal oxygen uptake was only moderately correlated with the predicted maximal oxygen uptake values (r = .39 to .59). Dolgener et al. (1994) developed an alternate regression equation for predicting maximal oxygen uptake in a college-age population that reports a higher correlation between actual and predicted maximal oxygen uptake than the original equation (Dolgener et al., 1994). Therefore, both equations from Kline et al. (1987), and Dolgener et al. (1994) were used to assess and estimate maximal oxygen uptake from the one-mile walk. Information about the specific procedures used with the one-mile walk is included in the methods section of this paper.

Balance

Balance was measured using a single-leg balance test completed as four separate trials on the left and right legs with the eyes open. Hoeger and Hoeger (2010) describe a single-leg balance test to measure changes in performance-related balance. Participants start with hands on the hips, the left knee bent approximately 90-degrees, and the left foot pressing against the inner thigh at the knee joint of the supporting leg. From this position, participants are instructed to lift the right heel off the floor so that the weight of the body is transferred to the ball of the right foot. Participants attempt to maintain balance as long

as possible, and the score on the test is the number of seconds the pose can be held for without compromising form. The test is terminated once the left foot touches the floor or if the right heel touches the floor or moves to accommodate swaying, the hands leave the hips, or the participant has maintained balance for 1-minute.

Validity for this single-leg balance test was not found. Another non-validated single-leg balance test was also used by Hart and Tracy (2008) to determine changes in balance with participation in Bikram yoga.

Flexibility

The choice of flexibility tests was based on the larger muscle size involved in the stretch, and the muscles that are stretched during Bikram yoga. The sit-and-reach test has long been used as a measure of hamstring flexibility. Hoeger and Hoeger (2010) describe the modified sit-and-reach test originally developed by Hoeger and Hopkins to control for differences in limb length. Limb length can disadvantage some participants in the regular sit-and-reach test, and may produce inaccurate scores for those disadvantaged participants. Minkler and Patterson (1994) reported that scores on the modified sit-and-reach are moderately related to criterion scores for hamstring flexibility for men and women ($r = 0.75$; $r = 0.66$). No reliability scores were reported, only a correlation to criterion measures.

The Bikram yoga sequence focuses on increasing the strength and range of motion of the trunk and upper body as well as hamstring flexibility. The total -body rotation test as described by the Canadian Physical Activity, Fitness and Lifestyle Appraisal and used in Hoeger and Hoeger (2010) and Nieman (2003) measures upper

body mobility and trunk and hip mobility. Hong et al. (2000) used this body rotation test to measure upper body mobility in Tai Chi Chuan exercisers. The total-body rotation test is a functional flexibility test, as the twisting motion mimics movements performed on a daily basis. No reliability data were found supporting this test, despite its apparent value as a functional flexibility test. The test demonstrates face validity in that intuitively it makes sense that it tests rotational flexibility based on its use in previous research.

CHAPTER THREE: METHODS

Participants

There were certain inclusion criteria for participation in this study. Current activity levels, body composition, psychological state, religious beliefs, gender or ethnicity did not exclude a participant from the study, but some of this information was recorded for data analyses. This information was collected using a demographic questionnaire. If participants were currently exercising, they were asked to maintain their current levels of activity throughout the duration of the study.

Male and female participants ($N = 51$) aged between 20-54 years ($M = 31.57$, $SD = 9.287$ years) were asked to attend at least three Bikram yoga sessions per week, resulting in a minimum of 24 total sessions averaged over eight weeks. The data analyses included data only from participants who attended at least 80% of this minimum requirement, even though 80 participants attended at least one session, and 66 participants completed both the pre- and post-intervention testing. The average attendance over the 8-week period was 28.59 ±9.21sessions.The majority of the participants were of Caucasian descent (94.1%), and 92.2% had a minimum of some college education. Table 1 in the Results section has further demographic information regarding participants' previous meditative and yoga experience, and physical activity levels.

Participants signed an Institutional Review Board (IRB) approved consent form stating that they understood the purpose of the study, and that they were healthy enough to participate in eight weeks of moderate to vigorous physical activity. Participants completed a medical history questionnaire to determine eligibility to participate, and were referred to a physician for further clearance if they reported pre-existing conditions that might have affected their participation in the study. Participants were screened for availability to participate in three to five 90 minute long Bikram yoga classes per week, and those who had excessive time demands that interfered with their full participation over the determined duration of the study were excluded from the study. It was imperative that participants had not participated in Bikram yoga on a long-term basis in the last two years, and had not participated in Bikram yoga regularly during the three months prior to the study. A potential participant, for example, who had attended Bikram yoga 12 times in the three months preceding the study, would be excluded from the study. If a participant used to attend Bikram yoga consistently (on a weekly basis), then it was required that they had not done so in the last two years if they were to participate in the study.

Age was not an exclusion criterion for participation in this study. In previous mindfulness research, age has not been an exclusion criterion suggesting that it is irrelevant when measuring mindfulness (Baer et al., 2008; Carmody & Baer, 2008). It was anticipated that the sample population would be comprised mostly of college-aged individuals.

Participants were recruited using an email distributed on the Boise State University campus and by word of mouth. Participation in the study was voluntary, and at any given point during the study, participants were able to withdraw. Participants were required to buy an introductory pass to Bikram yoga for $20 that allowed them to participate in unlimited yoga sessions for the 8-week period. Although the participants paid the $20 themselves, the regular cost of 8-weeks of Bikram yoga would be between $270 and $400.

The study was reviewed and approved by the Boise State University IRB to protect participants, and participants provided written consent for participation in the study. Data collection and storage took place in a manner that upholds participant confidentiality. Data were stored on a data storage drive that was locked in the Kinesiology building, Room K101-A at all times.

Measures

Several different assessments were used for data collection. Initially participants were asked to complete a consent form, medical questionnaire, and a physical activity readiness questionnaire (PAR-Q). The PAR-Q is a medical health questionnaire used to screen participants for pre-existing conditions that could interfere with participation in the study. The PAR-Q is a commonly used medical clearance tool that is recommended by ACSM (2006b). Additional questions were used to gather demographic information, and information regarding current activity levels and stress management strategies. The information collected was used for the analysis and the discussion to help explain the collected data. The information was used also to select appropriate field tests and

computations that were suitable for the specific sample. See Appendix B for copies of the consent form, the medical questionnaire, and the PAR-Q/demographic questionnaire form. After the 8-week program, one question was asked regarding participants' activity levels outside of Bikram yoga over the 8-week period (see Appendix B).

Mindfulness

To measure mindfulness, the FFMQ developed by Baer et al. (2006) was used. It measures mindfulness by observing five interrelated subscales: observing, describing, acting with awareness, nonjudging of inner experience, and nonreactivity to inner experience. The 39-item FFMQ has been used previously to measure mindfulness and was validated by Baer et al. (2008) as a suitable measurement tool for mindfulness. Baer et al. examined the construct validity of the FFMQ and reported correlations between the five facets (.32 to .56) that illustrate a relationship while still representing separate facets. The FFMQ was developed and validated based on previous questionnaires that were developed to measure the operationally defined construct of mindfulness. The Literature Review section of this paper explains the differing opinions with regards to questionnaires that measure mindfulness, and even whether self-report measures are suitable ways to measure mindfulness (Baer et al., 2006; Brown & Ryan, 2004; Grossman, 2008). However, this measure was chosen because there is a need to further explore a multi-faceted approach to understanding mindfulness (Baer et al., 2006). Each participant completed the questionnaire pre- and post-intervention. A score for each subscale was tallied, and an overall mindfulness score also was calculated. Measuring constructs individually and together may allow for further understanding of the

relationships between the individual subscales compared with measuring mindfulness as a single item construct. An example of a question is, “I don’t pay attention to what I’m doing because I’m daydreaming, worrying, or otherwise distracted”. The highest score possible is 195 representing a score of five on each of the 39 items (range = 1-5), and the lowest score possible is 39. Higher scores indicate a higher level of mindfulness (see Appendix C).

Perceived Stress

The 10-item Perceived Stress Scale (PSS) was used to measure stress (Cohen et al., 1983; Cohen & Williamson, 1988). This questionnaire was chosen based on its use in studies that were conducted to observe the relationship between stress and yoga (Carmody & Baer, 2008; Carmody et al., 2009; Granath et al., 2006). An example of a question is, “in the last month, how often have you found that you could not cope with all the things that you had to do?” Answers are recorded on a Likert scale from zero to four, and a higher score indicates a higher level of perceived stress. Scores range from zero to 40. Internal reliability of the 10-item PSS is reported at .78, indicating that it is as good as a measure of perceived stress as its 14-item scale predecessor (Cohen & Williamson, 1988). (See Appendix D for a copy of the 10-item PSS in its entirety, including the scoring guidelines.)

Cardiorespiratory Health

Resting heart rate was the first of two assessments that measured pre- and post-intervention cardiorespiratory health. Heart rate was measured using the radial pulse after sitting and completing the FFMQ questionnaire and PSS, and then resting in a supine

position for five minutes in order to get a more accurate record of a true resting value. True resting heart rate is most accurate first thing in the morning, which is why five minutes of supine rest preceded the resting heart rate measurement.

The second measure of cardiorespiratory health was a submaximal oxygen consumption test. Participants completed a 1.0-mile walk test in order to measure pre- and post-intervention changes in cardiorespiratory endurance using predicted VO_2max values. The indoor track at the Boise State University Recreation Center was used to complete the 1.0-mile walk. Participants started at the same time, and they were instructed to complete the walk in the fastest time possible without running. Participants were outfitted with a Polar heart rate monitor (A1 model, Lake Success, NY). Heart rate at the completion of the test and time to complete the 1.0-mile walk were recorded. Prior to and at the end of the test a general, low-intensity aerobic warm-up, and cool-down were conducted. Two equations were used to predict maximal oxygen uptake, and for college-age participants (18-30 years), maximal oxygen uptake was predicted using the following Rockport One-Mile Fitness Walking Test equation developed by Dolgener et al. (1994):

VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$) = 88.768 – (0.0957*weight lbs) + (8.892*gender) – (1.4537*time in minutes) – (0.1194*heart rate)

(Gender = 0 for female and 1 for male, and heart rate is taken at the end of walk)

Although a large percentage of participants were college-aged, the data from participants over the age of 30 were analyzed using the equation below (Kline et al., 1987):

VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$) = 132.853 – (0.1692*weight kg) – (0.3877*age) + (6.315*gender) – (3.2649*time in minutes) – (0.1565*heart rate)

(*Gender = 0 for female and 1 for male, and heart rate is taken at the end of walk*)

It was hypothesized that resting heart rate would decrease and cardiorespiratory endurance will increase after participation in 8-weeks of Bikram yoga, and to further validate potential findings, three participants were outfitted with Polar heart rate monitors during two Bikram yoga sessions to measure heart rate throughout the session. Although the number of participants wearing the heart rate monitors was small, data were collected to help determine exercise intensity during the yoga session and to describe any changes in cardiorespiratory fitness as measured by resting heart rate and the one-mile walk, submaximal VO_2max test. One male and two females between the ages of 22-23 years wore the heart rate monitors, and a target training zone (moderate to vigorous intensity) for cardiorespiratory exercise (50-85% heart rate reserve) was calculated for each participant using their resting heart rate and age (ACSM, 2006b). The percentage of time and actual time spent in this heart rate zone was calculated for descriptive data analysis.

Balance

A single-leg balance with the eyes open was used to measure balance pre- and post-intervention. A single-leg balance test was used by Hart and Tracy (2008). Hoeger and Hoeger (2010) describe a single-leg balance test where participants are instructed to leave their hands on their hips, lift one foot off the ground so that the knee bends and the heel is pressed against the inner thigh, and then raise up onto the ball of the standing foot. Balance times were recorded on the left and right sides, with the eyes open. Participants

balanced for as long as possible, until the heel of the standing foot touched the ground or the foot of the supported leg touched the ground. When necessary, the test was terminated after one minute on either leg. The best time of two trials under each condition was recorded.

Flexibility

Hamstring flexibility was measured using the modified sit-and-reach test described by Hoeger and Hoeger (2010). Participants sat against a wall with their legs straight and feet flexed against an Accuflex I Sit-and-Reach box (Novel Products, IL). Participants' arm reach was measured with the back and head upright against the wall, and the arms outstretched with the hands overlapping facing the ground. This position served as a relative 'zero' starting point. Then, they were instructed to overlap both hands and reach forward from the hips as far as possible in a controlled manner. Two trials were completed and the average of both trials was recorded in inches. Although no reliability scores were reported, the modified sit-and-reach is correlated to criterion measures for both men and women ($r = 0.75$; $r = 0.66$).

Transverse trunk and upper body flexibility was measured using a total-body rotation test as described in Hoeger and Hoeger (2010). Participants lined up perpendicularly with an Accuflex II Body Rotation Flexibility Tester facing away from the tester (Novel Products, IL). Participants were instructed to keep their feet planted as they rotated from the hips and upper body reach behind them as far as possible. A slide was pushed as far as possible and that distance was noted. Two trials on the left and right sides were completed and the average of both trials was recorded in inches. Face validity

was used to select this test to measure total body rotation. Scores obtained in the sit-and-reach and the total body-rotation tests were combined to form one flexibility score recorded in inches.

Data collectors were clearly informed of each tests' requirements and were responsible for determining termination of the test when requirements were not met. For example, if a participant failed to keep the knees straight during the sit-and-reach test then the test was terminated.

Procedures

Participant Recruitment

After an expression of interest in the study, potential participants attended an informational meeting in the Kinesiology building on the Boise State University campus to learn about the study, and to fill out the consent form, initial medical health questionnaire, PAR-Q, and demographic questionnaire. Participants completed all forms on campus at the time of the meeting. During this visit, a detailed description of the study and of Bikram yoga in particular was provided to participants. Requirements of the study were clearly stated, methods of data collection were described, and any questions posed by the participants were answered. Lastly, participants were asked to list their availability for pre-intervention data collection (i.e., second visit).

Pre-intervention

Physical fitness and psychological health assessments took place in the Human Performance Lab at Boise State University under the authority of an assistant professor, and his lab technician and graduate assistant. Pre-intervention measurements took place

within two weeks of the first yoga session. Data collection occurred over the course a week and a half, based on the availability of participants to come into the lab. The principal investigator was assisted by trained graduate students in order to collect data. The same students assisted with data collection pre- and post-intervention in order to improve inter-tester reliability. Participants arrived at the same time, and were tested in groups of no more than five. The group of five maximum helped to keep participants moving efficiently through the series of tests. Data collection took between 45-75 minutes for each group of participants both for pre- and post-intervention testing.

Participants first completed the FFMQ and PSS after arriving at the Human Performance Lab. Once the questionnaires were completed, the physical assessments began with a five minute resting period in a supine position.

Physical assessments of several components of fitness were measured, so testing order was important to maximize the accuracy of the measurements. Resting data were collected first, starting with resting heart rate, followed by body weight. Body weight was measured so it could be used as a component of the VO_2max predictor equations. After these components were recorded, participants completed a general warm-up that consisted of walking for five minutes on the treadmill, and completed two stretching exercises for the hamstrings and lower back. Nonfatiguing tests were completed first, including the sit-and-reach test, total-body rotation test, and single-leg balance test. After completion of these tests, participants were outfitted with a Polar heart rate monitor before the field test for cardiorespiratory endurance, which was measured last, as it required a prolonged and potentially fatiguing effort (Baechle & Earle, 2008). At the

completion of this test, the principal investigator tended to any unanswered questions by participants regarding preparation for the next eight weeks of yoga classes. After this brief discussion, the initial testing session was concluded.

After completion of the initial testing session, participants were informed that they could start their 8-week Bikram yoga program as early as the day the tests were completed. Participants were not required to start at the same time, although once initial tests had been administered, they were required to start their 8-week session within the following two weeks.

Intervention Protocol

Participants started their 8-week protocol within the two weeks following their data collection session. There were daily sign-in sheets at the Bikram Boise yoga studio specifically for participants in the study. The owner of Bikram Boise and a certified Bikram instructor, was the point of contact for the principal investigator, and for the participants if they required information outside of the capacity of the principal investigator. The Bikram Boise yoga studio is located at 3200 N Lake Harbor Lane in west Boise and is the only studio at which the intervention took place. The principal investigator monitored weekly attendance, and sent emails inquiring about the status of participants who do not attend the minimum required classes during a specific week, although low attendance did not automatically disqualify a participant from the study.

Participants were encouraged to attend five yoga sessions a week, however, an average of three sessions per week was acceptable. The inclusion criteria stated that availability for participation in five classes was optimal, but attendance at 80% of the

minimum 24 total sessions *over the course* of eight weeks was acceptable. This equated to attendance at a minimum of 20 out of 24 sessions for a participants' data to be used in the statistical analysis. Participants were encouraged to attend as many sessions per week as they desired, and felt comfortable with. There was no upper limit for weekly session attendance. Participants were encouraged to voice any concerns regarding any facet of participation in the study to the principal investigator or to the studio owner at any time during the study, and were notified that withdrawal from the study was acceptable at any time. An email was sent at the 4-week mark of the study to congratulate participants on their yoga attendance thus far, and to encourage their attendance at future yoga classes during the following four weeks of the study. Reminder emails were sent out for post-intervention testing appointments within a week of each participants' scheduled appointment.

Post-Intervention

Two weeks after the last participants had started their 8-week yoga program the principal investigator started scheduling post-intervention testing sessions in order to ensure that the testing sessions took place within one week of the completion of the program. After the completion of the 8-week Bikram yoga program participants returned to the lab for post-intervention testing as close to the same time of the day that their initial testing session took place as logistically possible. All participants were encouraged to come in for the post-intervention testing session regardless of the number of classes attended. The questionnaire and test order was the same as for the pre-intervention testing session.

Research Design and Data Analyses

A single-group pre- and posttest design was employed to determine the differences between pre- and post-intervention mindfulness, perceived stress, and physical fitness scores. If participants responded to recruitment emails and one-on-one conversations, and attended informational sessions, then they were able to participate in the study provided that inclusion criteria were satisfied.

Data were collected initially on paper, and then transferred to SPSS. Statistical analyses and interpretations were computed using computer program SPSS 18.0 (SPSS Inc., Chicago, IL). Descriptive statistics were used to describe the demographic information of the sample population collected from the demographic questionnaire.

To answer hypothesis (a) a multivariate analysis of variance (MANOVA) was used to examine the contribution of each of the five subscales of mindfulness towards the overall mindfulness scores. The significance was set at $\alpha = .05$. Once an overall significance level was established individual subscales of mindfulness were further analyzed using paired *t* tests in order to see where significant changes occurred. The significance level was Bonferroni corrected to account for the number of subscales in the test (.05/5 subscales) to .01.

Paired t tests were used to answer research hypotheses (b) through (f), which examined pre- and post-intervention changes in perceived stress, balance, flexibility, resting heart rate, and predicted VO_2max scores. Each component of fitness was examined with a separate paired t test, and the Bonferroni-corrected significance was set

at .01 (.05/5 subscales) in order to determine significant changes in overall physical fitness. The significance level was set at .05 for the perceived stress paired t test.

Pearson's correlation coefficients were used to answer research hypotheses (i) through (v). Correlations between mindfulness and each of the following components were observed: perceived stress, resting heart rate, predicted VO_2max, balance, and flexibility. Effect sizes were calculated for each outcome variable using the pre and posttest scores as the two population means, and the average of those two population standard deviations.

Following participant recruitment, meaningfulness and reliability of the correlations was determined. The degrees of freedom were determined (N – 2) and significance was set at $\alpha = .05$. A critical value for the correlation coefficient was determined using the closest possible degrees of freedom value, the level of significance, and a corresponding table of critical values (Thomas & Nelson, 1990). Thomas and Nelson (1990) refer readers to a table from *Statistical Tables for Biological, Agricultural and Medical Research* that is included in Appendix A of their text.

Observation of the correlations between measures of the mind and measures of the body may give further insight into the importance of including psychological and physical components in mindfulness research. Acknowledgement of the mind's profound effect on the body will strengthen the current rise of mind-based stress reduction programs that combine meditation with movement. Positive correlations between fitness scores and mindfulness scores may support the argument to include meditative

techniques in combination with traditional physical training to decrease stress, and improve exercise adherence, and quality of life.

CHAPTER FOUR: RESULTS

The purpose of this study was to examine the psychological and physical effects of an 8-week Bikram yoga program in an apparently healthy population of adults. The study also strived to examine the relationship, if any, between mindfulness, perceived stress, flexibility, balance, and cardiorespiratory endurance. Psychological outcome measures included the FFMQ, and the 10-item PSS. Physical outcome measures included resting heart rate, sit-and-reach and total-body rotation flexibility, single-leg balance, and the one-mile walk test. Participants were tested within two weeks of the start of the 8-week Bikram yoga program, and within one week of completion of the program.

Table 2 presents means and standard deviations for all the measured outcome variables. Participation in an 8-week Bikram yoga program increased levels of overall mindfulness, Hotelling's $T = 5.69$, $F\ (4, 47) = 66.8$, $p < .001$, $d = .89$, lowered levels of perceived stress, $t(50) = 6.19$, $p < .001$, $d = -.79$, did not change resting heart rate, $t(50) = 0.712$, $p = .243$, $d = -.09$, improved predicted VO_2max, $t(50) = 3.73$, $p < .001$, $d = .24$, improved flexibility, $t(50) = 11.48$, $p < .001$, d = .63, and improved balance, $t(50) = 4.51$, $p < .001$, $d = .53$. Table 3 illustrates the negative correlations between changes in mindfulness and changes in perceived stress ($r = -.431$, $p = .002$) and resting heart rate ($r = -.295$, $p = .036$).

Table 1

Participant Physical Activity Levels and Meditation Experience

Characteristic		Percent Response (%)
Meditative experience (**yes**)		52.9
Yoga experience (**yes**)		80.4
Bikram yoga experience (**yes**)		27.4
Current yoga activity (**yes**)		19.6
Current activity		
	Cardio and weights	47.1
	Cardio	21.6
	Cardio, yoga and weights	13.7
	Cardio and yoga	7.8
	None	5.9
	Yoga	3.9
Current activity duration (mins)		
	0-20	5.9
	20-45	17.6
	45-60	35.3
	60-90	29.4
	90+	11.8
All current activities frequency (sessions/week)		
	0-1	11.8
	1-2	11.8
	3-4	51.0
	5-6	21.6
	6+	3.9
Current activity intensity		
	No activity	2.0
	Low	3.9
	Low-moderate	19.6
	Moderate	25.5
	Moderate-vigorous	39.2
	Vigorous	9.8

Table 2 shows that there were significant changes in mindfulness scores ($p < .05$), perceived stress scores ($p < .05$), predicted VO_2max scores, flexibility scores and balance scores ($p < .01$). Effect sizes were medium to large for changes in the dependent variables ($d = .24$ - $.89$). See Tables 1, 2, 3 and 4 in Appendix E for more information on critical values, degrees of freedom, p values, and effect sizes for each statistical test.

Table 2

Changes in Mindfulness, PSS and Physical Fitness Variable

Characteristic	Pre-test (*M*±*SD*)	Post-test (*M*±*SD*)	Change (*M*)
Mindfulness			
Observe	29.06±5.31	31.2±4.14	+2.14***
Describe	29.16±4.21	30.82±4.19	+1.66***
Awareness	24.94±5.21	27.88±4.52	+2.94***
Non-reactive	22.1±3.75	24.75±3.65	+2.65***
Non-judging	26.84±4.85	30.29±4.81	+3.45***
Total	132.1±14.67	144.94±14.31	+12.84***
Perceived stress	17.04±5.89	12.35±6.00	-4.69***
Resting heart rate (bpm)	64.04±9.95	63.22±8.70	-1.28
Predicted VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	38.44±7.07	40.12±7.15	+1.68***
Flexibility (inches)	12.89±6.85	16.14±10.64	+3.25***
Balance (secs)	10.64±10.81	18.36±18.37	+7.72***

*** = $p < .001$.

Note: Overall mindfulness scores ranged from 39 to 195 with higher scores indicating higher levels of mindfulness. Perceived stress scores ranged from zero to 40 with higher scores indicating higher levels of perceived stress.

Table 3 presents correlations between difference scores in mindfulness, perceived stress, and the measured fitness variables. Changes in overall mindfulness were negatively correlated with changes in perceived stress and resting heart rate. Figures 1 and 2 graphically present the significant correlations. The critical value of the correlation coefficients = .2875 ($df = 49$, $\alpha = .05$). Both correlation coefficients are greater than the critical value indicating meaningfulness and reliability of the correlations, meaning that should future studies replicate the current study similar results are likely to be found.

Table 3

Correlations between Changes in Mindfulness and Perceived Stress, Resting Heart Rate, Cardiorespiratory Endurance, Flexibility, and Balance

Variable	Perceived stress	Resting heart rate	Predicted VO_2max	Flexibility	Balance
Mindfulness	r = -.431** p = .002	r = -.295* p = .036	r = -.232 p = .101	r = -.099 p = .487	r = .156 p = .275

* = $p < .05$
** = $p < .01$

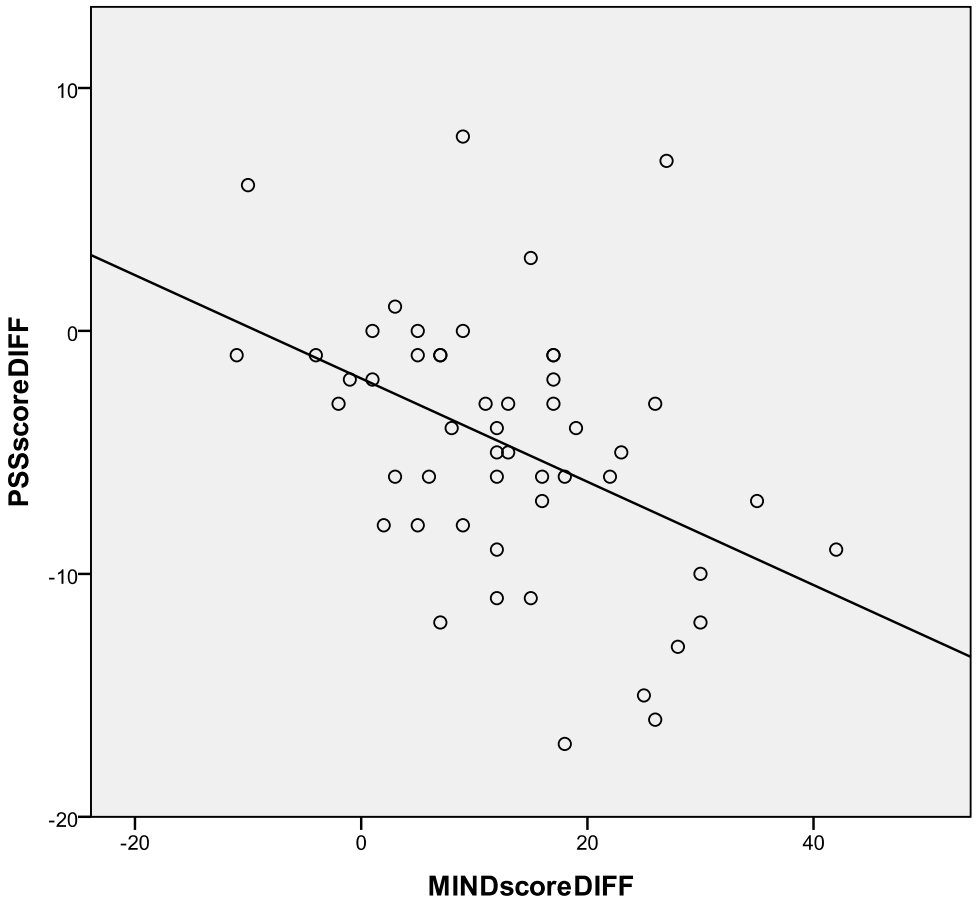

*Figure 1***.** Scatter plot correlation between changes in mindfulness and changes in perceived stress

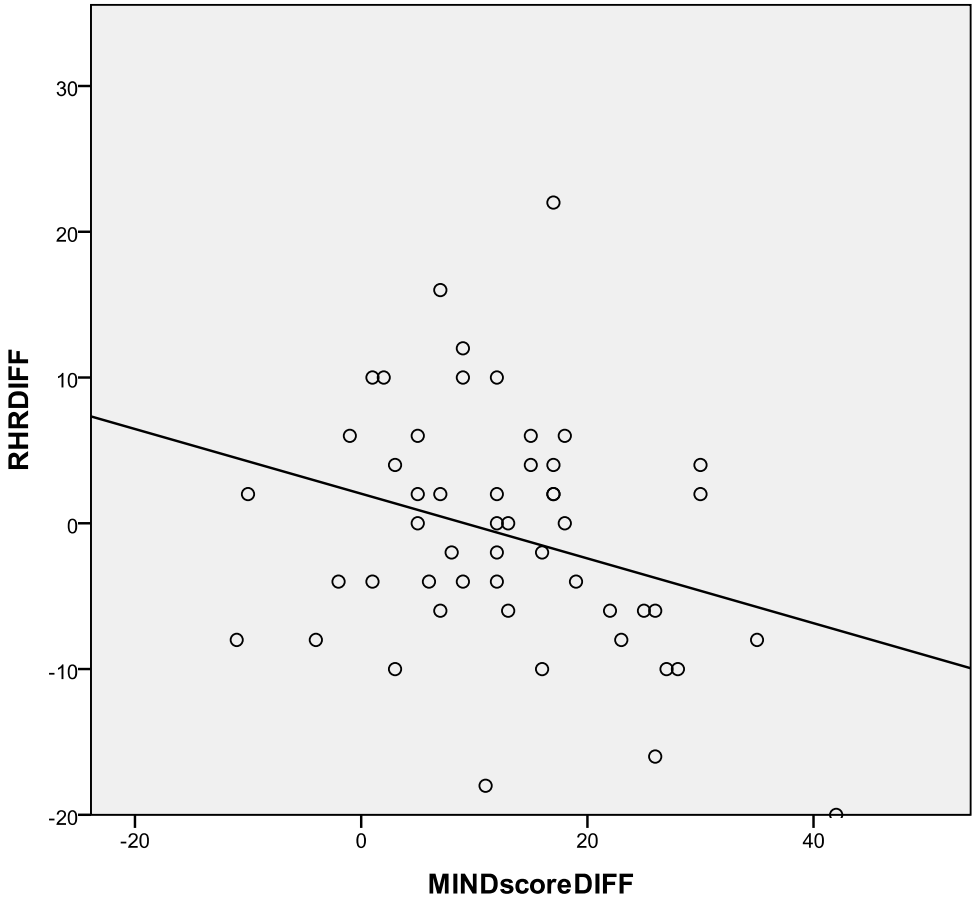

Figure 2. Scatter plot correlation between changes in mindfulness and changes in resting heart rate

Table 4 shows the average time spent and percentage of total workout time spent at an intensity between 50-85% of heart rate reserve for three participants who wore heart rate monitors for two sessions over the course of a one-week period.

Table 4

In-session heart rate averages

					Between 50-85%	Between 50-85%
	Age	Resting heart rate	50% heart rate reserve	85% heart rate reserve	Percentage of session	Time (mins)
Participant 1	22	62	128	177		
Session 1					68.4	69:40
Session 2					59	60:55
Participant 2	23	62	128	177		
Session1					39.2	37:15
Session 2					22	33:50
Participant 3	22	56	130	180		
Session 1					53.6	51
Session 2					22.9	30
Average	22.3	-	-	-	44.18 ±19:31	46:59 ±16:13

Table 5 presents the correlations between posttest scores for perceived stress and fitness, assuming posttest scores reflect training-related changes in the measured variables. Posttest mindfulness is significantly correlated with posttest perceived stress scores indicating that higher levels of mindfulness are associated with lower levels of perceived stress.

Table 5

Posttest scores correlations

Variable	Perceived stress	Predicted VO_2max	Flexibility	Balance
Mindfulness	r = -.776** p < .001			
Resting heart rate		r = -.300* p = .032	r = -.287* p = .041	
Predicted VO_2max				r = -.387** p = .005

* = p < .05
** = p < .01

CHAPTER FIVE: DISCUSSION

The most important findings of this study are that an 8-week Bikram yoga program resulted in positive, statistically significant changes in both psychological and physical variables. The first major finding of this study is that participation in an 8-week Bikram yoga program increased overall mindfulness and all five dimensions of mindfulness significantly. Although mindfulness has never been measured before and after a Bikram yoga intervention, this significant finding is consistent with previous studies that observed changes in mindfulness after participation in mind-based stress-reduction programs (Carmody & Baer, 2008; Carmody et al., 2009; Granath et al., 2006). Dependent *t* tests showed that all subcategories of mindfulness (i.e., observe, describe, aware, nonjudging and nonreactive) were significantly improved after participation in eight weeks of Bikram yoga. The "describe" category had the smallest change of the subcategories of mindfulness, which is similar to the findings of Carmody and Baer (2008) who found that the "describe" category did not change significantly after a MBSR intervention. Carmody and Baer also noted that their study revealed a positive relationship between the mindful yoga part of MBSR and mindfulness skills, even though the yoga component required less weekly practice than the body scan or seated meditation components. The current study supports the notion that mindful yoga positively affects levels of mindfulness, and suggests that Bikram yoga can be viewed as a concentrated technique for improving mindfulness when compared to programs

combining yoga with other techniques that have been developed specifically for the purpose of mindfulness-training based stress reduction.

Another positive effect of the 8-week Bikram yoga intervention was that perceived stress decreased significantly. These results were consistent with those reported in a study conducted by Woolery et al. (2004), which showed decreases in perceived stress in a slightly depressed group of participants who took part in a 5-week Iyengar yoga program. Carmody et al. (2009) also showed significant decreases in perceived stress in participants after eight weeks of a MBSR program. Granath et al. (2006) also showed that participants who engaged in 10 sessions of yoga over four months exhibited decreased levels of perceived stress. The results of the current study show promise for Bikram yoga to be used as a form of mind-based exercise to decrease levels of perceived stress. Perceived stress arises when a real or imagined stressor exceeds one's perceived capabilities to handle the situation (Seaward, 1994). Perceived stress may arise when thoughts are projected into the past or the future, which removes one's perceived control of a stressful situation. Bikram yoga helps to foster the connection between the mind and body by controlling the breath and keeping the mind attentive and aware of the present moment. Bikram yoga challenges the mind to remain in control as the sequence dictates movement through various challenging asanas. The temperature-controlled environment also adds to the mental challenge of Bikram yoga. The combination of being able to stay present in the moment and being able to control the breath while in a difficult asana in a challenging environment may be why Bikram yoga is effective in decreasing perceived stress. This finding is significant as stress-related illnesses continue to plague Western

culture creating a need for effective prevention and treatment options (American Psychological Association, 2007). As expected, changes in mindfulness were negatively correlated with changes in perceived stress. Carmody and Baer (2008) found similar results when examining the effects of an 8-week MBSR therapy program on participants suffering from chronic pain, anxiety, illness, and other stress-related problems. The significant correlation (r = -.431, p = .002) between mindfulness and perceived stress in the current study allows for further insight and understanding into the mechanism of the *post*-stress response, including how we can regulate our reaction to inevitable, stressful events when we cultivate our inherent ability to be mindful. The current study has shown that eight weeks of Bikram yoga helps to cultivate mindfulness, and might give people the tools to employ mindful strategies in stressful situations. The significant reduction in perceived stress might be related to the transfer from practicing mindfulness within the walls of the Bikram yoga studio to individuals' perceived realities of their outside lives. Stress reduction becomes a question of *how* we handle stressful events rather than eliminating such events from our lives, which is why Bikram yoga merits further attention in medical research as a means to prevent and treat stress-related illnesses.

A third major finding is that one aspect of cardiorespiratory health, (e.g., predicted VO_2max) improved as a result of this 8-week Bikram yoga program. This finding is in contrast to Clay, Lloyd, Walker, Sharp, & Pankey (2005) who determined that regular hatha yoga did not elicit metabolic workloads that met ACSM's guidelines for cardiorespiratory exercise prescription. Although the overall results from Clay et al.'s study stated that hatha yoga did not increase metabolic rate enough to be called

cardiorespiratory exercise, Clay et al. did find that the standing asanas (particularly the sun salutation series) elicited a metabolic response similar to the minimum ACSM requirements for physical activity to improve health. The current study used a submaximal VO_2max prediction one-mile walk test to show significant improvements in predicted VO_2max after participation in eight weeks of Bikram yoga.

In order to offer at least one explanation for this improvement in cardiorespiratory fitness, heart rate data were collected during several Bikram yoga sessions from three participants. Although Clay et al. mentioned that heart rate has been shown to be disproportionately high when compared to metabolic cost during hatha yoga, within the scope of this study measuring heart rate was the most advanced instrument available. The time spent in ACSM's recommended heart rate zones for moderate to vigorous exercise (50-80% heart rate reserve) was almost 47 minutes (out of 90 minutes total), which is within ACSM's guidelines for duration of an aerobic exercise session. Bikram yoga may elevate heart rate because of the heated room, and because of the constriction and redistribution of blood flow with the movement through different asanas. The heart continues to pump blood to all of the extremities despite the constriction of blood flow to the limbs in certain poses. This unorthodox explanation for enhancing cardiorespiratory endurance may strengthen the heart, which may lead to improvements in cardiorespiratory health.

Clay et al. (2005) did report that heart rate during hatha yoga was considerably high when compared to actual metabolic cost. This information may indicate that using heart rate as a measure of intensity as we understand it in traditional aerobic exercise

does not align with metabolic values at the same intensity when looking at hatha yoga. However, although the metabolic cost of hatha yoga as measured by Clay and colleagues registered only the sun salutations as metabolically comparable to the minimum aerobic intensity, the metabolic cost of Bikram yoga might differ.

Regardless of whether hatha yoga elicits a significant metabolic response, the fact remains that in the three participants selected heart rate remained elevated within the moderate to vigorous training zones for more than 40 minutes, which indicates that the heart muscle was working hard and working constantly. With no published information on the metabolic cost of Bikram yoga, the temporary elevation in heart rate associated with participation in Bikram yoga still might lead to benefits in the cardiovascular system that are commonly associated with aerobic exercise, such as enhanced blood vessel health, decreased resting blood pressure (and heart rate if all contributing factors are controlled) increased endurance and strength of the heart itself, and improved circulation. Further examination of both the heart rate response and the metabolic response to Bikram yoga could further establish the potential cardiorespiratory benefits of Bikram yoga.

Contrary to the positive impact of Bikram yoga on cardiorespiratory fitness, the impact of the intervention on resting heart rate was negligible. Resting heart rate is difficult to measure because it is affected by many things (e.g., caffeine, medications, acute stress levels, previous bouts of activity). In addition, resting heart rate is somewhat variable. Resting heart rate was not measured in the previously discussed studies that used yoga or another form of mind-body therapy as an intervention technique. This is

likely because the previously discussed studies were not concerned with the cardiorespiratory benefits of a mind-body exercise program.

Some participants mentioned, as they came in for their post-intervention testing, that they had just ingested caffeine, or had rushed to get to their appointment. Although a period of rest was built into the testing protocol to offset factors that contribute to increased or decreased heart rate, there is no way of knowing whether or not factors such as caffeine, stress or medications affected resting heart rate values before and after the intervention. More specific instruction for testing preparation from the principal investigator in the future might help to decrease resting heart rate variability.

Although there was no significant difference between pre- and post-intervention resting heart rate values, changes in resting heart rate were negatively correlated with changes in mindfulness (r = -.295, p = .036) as hypothesized. This finding is meaningful because the participants who had lower resting heart rates after participation in eight weeks of Bikram yoga also reported higher levels of mindfulness. This might indicate that they were more mindful of the control they can exert of the autonomic function of breathing, which is a focus in the practice of yoga, and they may have exercised this control while having their posttest resting heart rate measurement.

A fourth important finding is that flexibility significantly improved with participation in eight weeks of Bikram yoga. A previous study examining the effects of Bikram yoga on flexibility was not found, although based on informal testimonials and the nature of Bikram yoga, it is not surprising that flexibility was improved. Several asanas in the Bikram yoga series emphasize hamstring flexibility, which may explain

why Bikram yoga resulted in increased flexibility. The total-body-rotation test proved to be a source of great improvement in the majority of participants. Due to the nature of this test, it is difficult to determine what led to these improvements. Possible contributions include increased thoracic mobility, shoulder mobility, and mobility of the muscles supporting both the pelvis and the trunk. Mobility better describes the possible effects rather than flexibility, as increases in strength combined with increases in flexibility could be responsible for changes in the total-body-rotation score rather than flexibility alone.

A fifth major finding was that balance improved after participation in eight weeks of Bikram yoga. This result is consistent with the results found by Hart and Tracy (2008), even though the balance test used was slightly different. The test in the current study instructed participants to lift their heel off the ground while standing on one leg instead of keeping the heel on the ground as was done by Hart and Tracy. The improvement in balance could be explained by several factors. First, as Hart and Tracy hypothesized, yoga may decrease sympathetic nervous system activity through the control of the breath, and this may have lead to increases in steadiness while balancing. Second, muscular endurance in the muscles of the hip, leg, and ankle may have improved, enabling participants to balance longer. Third, proprioceptive awareness may have improved, enabling participants to remain balanced and return from an unbalanced state more efficiently.

Although there were no significant correlations between mindfulness and physical fitness (i.e., cardiorespiratory endurance, flexibility and balance), this finding *itself* is

interesting and worthy of discussion. This finding may indicate that it is not necessary to experience gains in physical fitness in order to experience improvements in mindfulness and in perceived stress. An assessment of intervention-related changes in physical self-competency may help to reveal why psychological health improves as a result of a Bikram yoga program but not in correlation with physical fitness improvements.

In addition to the quantitative measurements, qualitative feedback was also informally noted and it is worthwhile to include it in this study. To ignore participants' individual feedback undermines the very nature of mind-body based exercise interventions. The purpose of this section is not to qualitatively analyze formal responses from participants in a scientific manner, as a qualitative approach was not used to measure intervention-related changes. However, previous research has indicated a lack of understanding about what mindfulness is, how it is measured, and what the implications of current definitions and measurement techniques are (Bishop et al., 2004; Brown & Ryan, 2004; Christopher et al., 2009; Grossman, 2008). Based on the knowledge that mindfulness is difficult to measure, the purpose of this section is to give a brief synopsis of participants' personal feedback that did not fall into a measured outcome included in this study's protocol.

The most common thread of feedback was that participants reported an increased quality of sleep without their hours of sleep necessarily changing. One participant reported that she stopped taking her sleep medications because they were not needed due to her participation in Bikram yoga. Several participants also reported that they had gone down one or two pant sizes despite no change in their body weight as measured at their

post-intervention testing appointment. This may indicate that although not measured, body composition changes may occur in some participants, and it indicates that eight weeks of Bikram yoga may help to preserve and build lean body mass while decreasing fat mass.

A few participants mentioned that starting up their spring sports (e.g., ultimate Frisbee and kayaking) was easier than in years past. For example, one participant mentioned that she always worries about being fit for the start of the kayaking season. After her first day of the season on the river, she reported improved endurance, and she noticed she was using her breath to control her mind as she navigated down the river. She also acknowledged a gained mental toughness that helped her believe that she could tackle the river, even telling herself that if she could get through 90 minutes of Bikram yoga, she could surely walk up the hill from the river carrying her kayak over her head.

Despite the positive and noteworthy findings, there are several limitations associated with this study. As mentioned in the Introduction, the sample population may have been limited by recruitment techniques, the $20 fee associated with participation, location and duration of the classes, and the potential discomfort that Bikram yoga may have caused some participants.

The results of this study can be generalized only to healthy, Caucasian adults aged between 20 and 54 years old who have at least some college education. Also, more women than men participated in the study, which may skew the results to over-represent females, and under-represent males. The PSS results may have been skewed because daily stresses cannot be controlled, and PSS results may vary each time the questionnaire

is completed. Participants were from a convenience sample so personality contributions to the results of the study could not be controlled.

A limitation of the study design was the absence of a control group, which does not allow for intervention-related changes to be compared with maintenance of current behaviors. A further limitation of the study design was the choice of field tests that were used to measure changes in physical fitness. With the limited amount of research on Bikram yoga, assessment tools were chosen based mainly on face validity, and because these tests can be used by the participants as assessment tools once the program is complete. Also, the one-mile walk test was chosen because of the large age and fitness span of the sample, but may not have been the most accurate VO_2max predictor test, especially for more active participants.

The psychological questionnaires could have unfairly represented intervention-related changes in mindfulness and perceived stress due to the time at which they were taken. A large portion of the sample size was recruited from the Boise State University student population and the post-intervention testing took place during the seventh and eighth weeks of school when several classes hold midterm exams. Daily stresses, such as an exam, could have influenced responses on the questionnaires.

Preparation for the pre- and post-intervention testing sessions was not specified by the principal investigator. Participants were instructed to wear appropriate attire for working out (e.g., running shoes) but were not told to abstain from caffeine, medications, or specific foods before testing. Overlooking this fact may have affected the resting heart rate values, as it was unknown whether a participant had just ingested a large coffee, or

perhaps they were running late and so they sprinted from their car to arrive on time. All of these external factors could have affected the resting heart rate measurements, even though a five minute supine resting period preceded heart rate measurements, and would attenuate any activity-related increases in resting heart rate.

The last limitation that could have influenced results was the fact that participants were recruited as a convenience sample. A convenience sample design fails to account for personality contributions to the results of the study. In other words, participants with a particular personality trait or combination of traits might have been more apt to sign up for this study as compared to others without certain personality traits.

Despite limitations, this study is one of the first to assess the psychological and physical effects of Bikram yoga and to find significant improvements in both of these central dimensions of health. The greatest contribution this study can make to the academic community is to generate a starting point for measuring psychological health and physical fitness together with relation to mind-body forms of exercise. The current study can be used as a guide for future research related to Bikram yoga. Due to the positive findings in this study as well as the positive feedback from participants, there is a need to further research the effects of Bikram yoga and how it may increase mindfulness and reduce of stress and potentially stress-related illnesses.

Participants in this study reported negative correlations between mindfulness and perceived stress. If one's perception is one's reality, then perceived stress may lead to an allostatic load on the body, which in turn leads to stress-related illnesses. This study showed that Bikram yoga is effective at reducing perceived stress, and understanding

how this relates to the current method of yoga or exercise prescription for the prevention or cure of stress-related illnesses is vital. Prescribing Bikram yoga versus medication for the treatment and, more importantly, the prevention of stress-related illnesses would be a significant triumph for nontraditional, mind-body based remedies that are currently not recognized as serious prescriptions for chronic illnesses.

The improvement in predicted VO_2max scores after eight weeks of Bikram yoga is of great significance considering the importance of aerobic exercise to general health and well-being. Bikram yoga is a nonimpact exercise that, with further research, might be considered comparable to some forms of recommended aerobic exercise. Assuming positive results of such research would allow people with injuries or illnesses that prevent them from participating in traditional aerobic exercise to still experience gains in cardiorespiratory health through Bikram yoga.

It is possible that increased mobility of the spine and hamstrings as shown by the flexibility tests could help to alleviate lower back pain associated with muscular imbalances across the pelvis and spine joints. Clearly more research in this area is needed.

This study joins only a handful of other published studies examining the physical or psychological effects of Bikram yoga, adding to the small pool of published research that currently exists. Although the results of this study are encouraging, several improvements could be made to the design of the current study to deepen the investigation into the potential mind and body benefits of engaging in Bikram yoga as a mind-body exercise.

Future studies with Bikram yoga should incorporate a control group, and even a second experimental group in order to compare Bikram yoga to various exercise alternatives. It would be valuable to determine the effects of Bikram yoga when compared with engagement in no exercise, and also with engagement in more traditional forms of exercise including resistance training and aerobic exercise or a combination of the two. Also, physical fitness levels were not controlled in the analysis in this study. In future studies it would be valuable to control for physical activity levels during the study.

The sample population could be further randomized in future research in order to avoid a personality bias of those choosing to participate. Also, experimenting with different clinical populations, for example, those with clinical depression, could help us to investigate an potential exercise-based alternative to medicinal intervention.

Perhaps the most significant recommendation for future research lies in the contradiction of measuring psychological health with quantitative measures only. Whether mindfulness can or should be measured has been discussed in previous research, and the development of psychological questionnaires is still in its infancy (Bishop et al., 2004; Brown & Ryan, 2004; Christopher et al., 2009). The psychology of any individual is hard to measure without in depth, qualitative research, and mindfulness, which has only become a topic of research in the West in the last 20 years, is still at risk of being measured inaccurately at this stage of its 'scientific' existence. As shown informally by this study, Bikram yoga affected participants' lives beyond that which the instruments in this study could measure. Future research should work to incorporate a mixed-methods approach when choosing and evaluating outcome measures, which will allow for an in

depth analysis of how Bikram yoga affects mental, and emotional health, and how that adds to the lives of those who participate in Bikram yoga.

As mentioned previously, a lack of previous research made it difficult to accurately select field tests to measure intervention-related changes in flexibility, balance, and cardiorespiratory health. Further research into the physical effects of Bikram yoga should use the same tests to see if the same results are replicated. Also, muscular strength or endurance was not measured in this study, yet is a crucial part of joint stability and mobility, and overall joint health. Future research could explain in more detail the effects of Bikram yoga on mobility of the joints of the body if muscular strength, endurance, and flexibility were all measured within the same study. Included in the original proposal of this study was the use of a wall-sit to measure muscular endurance. A similar test or the same proposed test could be used in future research to observe the changes in muscular endurance after an eight week Bikram yoga program.

Body composition was also originally included as an outcome measure of this study, but it was removed to simplify the study design. Based on the informal feedback from participants at their post-intervention testing session regarding the fit of their clothes, it would be valuable to measure intervention-related changes in body composition in future research with Bikram yoga. Including a measurement of the metabolic cost during Bikram yoga would complement the measurement of body composition in future research.

Although significant changes were seen with predicted VO_2max, observation of the one-mile walk test indicated that effort and current fitness level could have altered

predicted VO_2max in some individuals. The test seemed to underestimate VO_2max values in more fit, college-aged individuals. It may be worthwhile to experiment with a different predictive VO_2max test, a maximal effort VO_2max test, or a combination of submaximal and maximal tests based on the starting fitness level of the sample population. Also worth further attention is the in-session heart rate collection protocol. Noting the resting heart rate in the hot yoga room might help to explain and control for the contribution of the heat to the increased heart rate during Bikram yoga.

The results of this study could be further enhanced with a more invasive approach to data collection that would help to answer more specific research questions. For example, including an analysis of the levels of certain stress markers, such as cortisol, may give further insight into the physiological response to Bikram yoga.

There are several suggestions for future research with regards to data analyses. Performing a canonical correlation could help to further analyze the psychological and physical components of health and wellbeing. Also, it may be of value to examine the relationships between mindfulness, perceived stress, physical fitness and attendance rates, dropout rates or meditative experience. This could reveal valuable information that would assist in recommending a minimum weekly attendance prescription of Bikram yoga for improvements in any of the significant outcome measures in the current study.

Lastly, future research of Bikram yoga would be enhanced by the addition of epidemiological research showing the connection between chronic illnesses and stress. This study looked at the mindfulness cultivated from the practice of Bikram yoga, and the decreased perceived stress that was experienced with participation in Bikram yoga. The

contribution of the positive findings revealed in the current study to physical and psychological health could be interpreted further if the link between stress and chronic illnesses was better researched and defined.

Conclusion

The purpose of this study was to examine how the mind-body based exercise of Bikram yoga affects physical and the mental health in apparently healthy people. Despite its growing popularity and unique method of instruction, Bikram yoga has not been researched extensively in previous studies. The switched on, tangibly engaged environment that Bikram yoga and its instructors generate leaves little time in the mind of the practicing yogi to be distracted with past or future events that may cause them stress. The instructors continuously encourage the class to stay present with their experience, be mindful of the way their bodies move, and observe the control they have over the breath that enters and leaves the lungs as the mind places different demands upon the body. With time, the ability to foster what many researchers have called inherent but culturally dormant in Western societies, can be cultivated and called upon during times of need in daily life. It may be impossible for the Westernized population to be in a mindful state 24 hours of the day, but the ability to trigger this state of mind and use the tools learned in Bikram yoga to get to that state when needed is imperative in preventing over-arousal of the sympathetic nervous system and the subsequent stress response. Remaining in an elevated state of stress can cause detrimental hormonal, mental, and even physical overload on the body, and stress-related illnesses ranging from a common cold to a myocardial infarction.

From a physical standpoint, Bikram yoga helps to create a more flexible and balanced body, allowing the body to move with more ease in its natural and optimal state of functioning. Incorporating Bikram yoga into a lifestyle, for example as part of a medical prescription to prevent or treat chronic muscular imbalances across certain joints, could help the joints of the body realign over time without the sole reliance on physical therapy or surgery for overuse injuries.

This study was designed as a platform to generate more scientific interest in and thoughtful deliberation about Bikram yoga's significant contribution to the traditional schools of thought that are used to prevent and treat chronic diseases related to stress and inactivity. The sample in the current study experienced significant improvements in mental and physical health in the short period of eight weeks. Levels of mindfulness and perceived stress improved significantly and were significantly correlated, and there were significant improvements in flexibility, balance, and cardiorespiratory endurance.

The results of this study have practical implications worthy of further research attention. The current state of human well-being, as expressed by the high incidence of stress-related illnesses and inactivity, demand that such formal research is undertaken. As demonstrated by this study, the benefits of using Bikram yoga as a mind-body based exercise program are apparent, and future research is essential for a more in depth medical understanding and appreciation for this form of yoga.

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APPENDIX A

The Bikram Yoga Sequence & Asana Names

The Bikram Yoga Sequence

http://mainasukhumvit.files.wordpress.com/2006/10/postures.JPG
Retrieved: 9/10/2009

Asana Names

Postures are listed in Sanskrit and then in English

1. Pranayama (standing deep breathing)
2. Ardha-Chandrasana (half moon pose), Pada-hasthasana (hands to feet pose)
3. Utkatasana (awkward pose)
4. Garurasana (eagle pose)
5. Dandayamana-Janushirasana (standing head to knee pose)
6. Dandayamana-Dhanurasana (standing bow pose)
7. Tuladandasana (balancing stick pose)
8. Dandayamana-Bibhaktapada-Paschimotthanasana (standing separate leg stretching pose)
9. Trikanasana (triangle pose)
10. Dandayamana-Bibhaktapada-Janushirasana (standing separate leg head to knee pose)
11. Tadasana (tree pose)
12. Padangustasana (toe stand)
13. Savasana (dead body pose)
14. Pavanamuktasana (wind-removing pose)
15. Bhujangasana (cobra pose)
16. Salabhasana (locust pose)
17. Poorna-Salabhasana (full locust pose)
18. Dhanurasana (bow pose)
19. Supta-Vajrasana (fixed firm pose)
20. Ardha-Kurmasana (half tortoise pose)
21. Ustrasana (camel pose)
22. Sasangasana (rabbit pose)
23. Janushirasana (head to knee pose)
24. Paschimotthanasana (stretching pose)
25. Ardha-Matsyendrasana (spine-twisting pose)
26. Kapalbhati in Vajrasana (blowing in firm pose)

APPENDIX B

Consent, Medical, and Demographic Forms

CONSENT TO BE A RESEARCH PARTICIPANT

BOISE STATE UNIVERSITY

A. PURPOSE AND BACKGROUND

Zoe Hewett, M.S. student, and Lynda Ransdell, Ph.D. in the Department of Kinesiology at Boise State University are conducting a research study entitled "An examination of the effectiveness of an 8-week Bikram yoga program on mindfulness and physical fitness." The purpose of this study is to help understand how Bikram yoga, a mind-based form of exercise, can elicit changes in mindfulness as well as physical fitness. You are being asked to participate in this study because you are a healthy volunteer, over the age of 18.

B. PROCEDURES

If you agree to be in the study, the following will occur:

1. You will participate in an 8-week Bikram yoga program, attending a minimum of 3 one-and-a-half hour sessions of yoga per week (5 sessions per week are recommended).

2. Before and after the 8-week program, you will be required to come to Boise State University (BSU) campus for an evaluation of your level of mindfulness and physical fitness (cardiorespiratory health, flexibility, and balance).

3. Completion of the tests before and after the intervention may take up to 1 hour for each visit.

4. You will be required to perform physical fitness assessments and to fill out a questionnaire (Five-Facet Mindfulness Questionnaire) that evaluates your present-moment awareness. Other written measures include a physical activity readiness questionnaire (PAR-Q), medical information form, a demographic questionnaire, and the Perceived Stress Scale.

The initial and final data collection procedures will be done at the Human Performance Laboratory in the Kinesiology department on the BSU campus. Cardiorespiratory health will be measured by taking a resting heart rate measurement at the radial artery, and by completing a one-mile walk around the track. These tests are suitable for participants above the age of 18 and are not considered maximal exertion tests. Heart rate and time to completion will be used in an equation to determine fitness level from the one-mile walk. Hamstring flexibility will be measured using a modified sit-and-reach test. Participants will sit on the floor with legs stretched out straight and together, and will reach as far as

possible forwards towards their toes. Measurement will be recorded in inches. Trunk rotation flexibility will be measured using a total-body rotation tool. Participants will be instructed to keep their feet planted as they turn their upper body and arms behind them to reach as far as they can. Measurement will be recorded in inches.
Balance will be measured using a single-leg balance test with the hands placed on the hips and the free leg bent and placed on the inner thigh of the supporting leg. Participants will be instructed to rise up onto the ball of their foot and hold that balance for as many seconds as they can. Both left and right sides will be tested.
The 8-week Bikram yoga program will take place at "Bikram Boise" yoga studio, which is located at 3200 Lake Harbor Lane, Suite 159, Boise ID, 83703. Several classes are offered each day of the week and participants will be able to choose which times they attend class.

C. RISKS/DISCOMFORTS

1. Bikram yoga is a challenging form of yoga and exercise. The yoga takes place in a room heated to 105 degrees F, which may be unpleasant initially. It is important that you assess how you are feeling during the class so that you can adjust accordingly (e.g. sit down for a few minutes) if necessary.

2. Some of the postures can make the novice participant feel nauseous. It is important that you assess your own discomfort, and if necessary, sit down until you feel able to continue.

3. Some of the postures are very physically challenging, and participants are always encouraged to perform the yoga to the best of their *personal* ability, and according to how they feel that day. If a particular pose is painful (versus uncomfortable) and you do not wish to perform it at that time, you may stop a pose at any time.

4. Confidentiality: Participation in research may involve a loss of privacy; however, your records will be handled as confidentially as possible. Only Zoe Hewett and Lynda Ransdell will have access to the study records. No individual identities will be used in any reports or publications that may result from this study. In addition, participant confidentiality will be communicated to participants and will be strictly upheld.

5. If at any time you wish to withdraw from the study, you may do so with no questions asked.

D. BENEFITS

You will likely experience many physical and psychological benefits from participation in this study. You will also receive 24-40 sessions of Bikram yoga at a drastically reduced price
.

E. COSTS

There is a fee of $20 associated with participation in this study. The value of 8-weeks of unlimited yoga is $270-$400. The study will also cost a minimum of 4.5 hours (exercise time) plus travel time per week, and approximately 2 hours of your time before and after the study for data collection.

F. PAYMENT

You will not be paid for participation in this study.

G. QUESTIONS

If you have any questions or concerns about participation in this study, you should first talk with the investigators. Zoe Hewett can be reached at zoehewett@u.boisestate.edu, or at 208-426-4270 and Lynda Ransdell can be reached at lyndaransdell@boisestate.edu or 208-426-1798. If for some reason you do not wish to do this, you may contact the Institutional Review Board, which is concerned with the protection of volunteers in research projects. You may reach the board office between 8:00 AM and 5:00 PM, Monday through Friday, by calling (208) 426-5401 or by writing: Institutional Review Board, Office of Research Compliance, Boise State University, 1910 University Dr., Boise, ID 83725-1138.

Should you feel discomfort due to participation in this research and you are a BSU student, you may contact the Boise State University Health and Wellness Center for counseling services at (208) 426-1601. If you are not a BSU student and you feel discomfort, you should contact your own health care provider.

H. CONSENT

You will be given a copy of this consent form to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY. You are free to decline to be in this study, or to withdraw from it at any point. Your decision as to whether or not to participate in this study will have no influence on you present or future status as a student or employee at BSU.

I give my consent to participate in this study:

Signature of Study Participant Date

Signature of Person Obtaining Consent Date

THE BOISE STATE UNIVERSITY INTSTITUTIONAL REVIEW BOARD HAS REVIEWED THIS PROJECT FOR THE PROTECTION OF HUMAN PARTICPANTS IN RESEARCH.

PAR-Q & Demographic Questionnaire

PAR-Q

The PAR-Q is a PDF document that can be downloaded from the Canadian Society for Exercise Physiology (CSEP) website. The PAR-Q can be viewed at:

http://www.csep.ca/CMFiles/publications/parq/par-q.pdf. (Retrieved: 9/28/2009).

A downloaded version of the PAR-Q as it appears at the above website (copy and paste URL) will be printed and used for participation clearance.

Demographic Information

The following questions regarding demographics will be asked in addition to the consent form and the PAR-Q.

1. Describe your current activity level during the past 3 months:
    a. Number of sessions per week _____
    b. Duration of sessions (minutes)_____
    c. Type of activity/activities_____
    _____
    _____
    _____
    _____
    d. Circle the level of intensity of your most frequent activity of your current program:
        i. Low
        ii. Low-to-moderate
        iii. Moderate
        iv. Moderate-to-vigorous
        v. Vigorous
    e. Add further description here if necessary
    _____
    _____
    _____
    _____

2. Age (years)_____

3. Ethnicity (please circle)
    a. African American
    b. Caucasian
    c. Hispanic
    d. Native American
    e. Other (please list)_____

4. Highest education level_____
5. Do you have previous meditative experience? Yes No (circle one)
    If "yes", please describe duration and type, and whether or not you are currently meditating_____
    _____
    _____
    _____
    _____

6. Do you have previous yoga experience? Yes No (circle one)
   If "yes", please describe duration and type, and whether or not you are currently participating in yoga_____
   _____
   _____
   _____
   _____

7. Why did you sign up for this study and agree to participate in Bikram yoga?
   _____
   _____
   _____
   _____

Post-intervention Demographic Form

Participant number_____

Age_____

Overall, how did you change your regular physical activity participation OUTSIDE of the Bikram yoga sessions you attended in the last 8 weeks? Circle the appropriate answer:

a) There was no change to normal physical activity levels
b) I increased my normal physical activity levels
c) I decreased my normal physical activity levels

Medical Information Form
BSU Department of Kinesiology

Name: _____
Address: _____
City & State: _____
Phone Numbers: _____
Email Address: _____

Emergency Contact (Name/Phone #): _____

Insurance: Each person is responsible for their own personal medical expenses. For your personal financial protection, sickness and accident insurance is recommended.

Medical Information (your information will remain confidential): In the space provided below, please indicate whether you are on medications and reasons for taking such medications, have any allergies to food, bee stings, or other allergens, or have any reactions to medications. Also indicate any medical condition that might require modifying your exercise program or prevent you from safely participating in exercise. Please inform the principal investigator if you are pregnant.

Permission for Medical Care. Please read carefully and sign in the space provided. Consent is given for the signee to participate in this Bikram yoga research program. Permission is given for any emergency anesthesia, operation, hospitalization, or other treatment that might become necessary. You should know that many participants with a variety of medical/psychological difficulties have participated in Bikram yoga over the years, but we must be aware of these conditions. Failure to disclose such information could result in serious harm to you and your fellow participants. If you are unable to physically participate in this program because of a pre-existing condition that was not indicated on this medical form, we cannot help you modify your participation appropriately and we may be limited in the help we can provide in an emergency situation. Please be honest so we can help accommodate your needs and develop a safe and effective conditioning program for everyone.

Participant Signature: _____ Date: _____

APPENIDIX C

Mindfulness Assessment Instrument

5-FACET MINDFULNESS QUESTIONNAIRE

Please rate each of the following statements using the scale provided. Write the number in the blank that best describes <u>your own opinion</u> of what is <u>generally true for you</u>.

1	2	3	4	5
never or very rarely true	**rarely true**	**sometimes true**	**often true**	**very often or always true**

_____ 1. When I'm walking, I deliberately notice the sensations of my body moving.
_____ 2. I'm good at finding words to describe my feelings.
_____ 3. I criticize myself for having irrational or inappropriate emotions.
_____ 4. I perceive my feelings and emotions without having to react to them.
_____ 5. When I do things, my mind wanders off and I'm easily distracted.
_____ 6. When I take a shower or bath, I stay alert to the sensations of water on my body.
_____ 7. I can easily put my beliefs, opinions, and expectations into words.
_____ 8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
_____ 9. I watch my feelings without getting lost in them.
_____ 10. I tell myself I shouldn't be feeling the way I'm feeling.
_____ 11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
_____ 12. It's hard for me to find the words to describe what I'm thinking.
_____ 13. I am easily distracted.
_____ 14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
_____ 15. I pay attention to sensations, such as the wind in my hair or sun on my face.
_____ 16. I have trouble thinking of the right words to express how I feel about things
_____ 17. I make judgments about whether my thoughts are good or bad.
_____ 18. I find it difficult to stay focused on what's happening in the present.
_____ 19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.
_____ 20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
_____ 21. In difficult situations, I can pause without immediately reacting.
_____ 22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.
_____ 23. It seems I am "running on automatic" without much awareness of what I'm doing.
_____24. When I have distressing thoughts or images, I feel calm soon after.

_____ 25. I tell myself that I shouldn't be thinking the way I'm thinking.
_____ 26. I notice the smells and aromas of things.
_____ 27. Even when I'm feeling terribly upset, I can find a way to put it into words.
_____ 28. I rush through activities without being really attentive to them.
_____ 29. When I have distressing thoughts or images I am able just to notice them without reacting.
_____ 30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
_____ 31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
_____ 32. My natural tendency is to put my experiences into words.
_____ 33. When I have distressing thoughts or images, I just notice them and let them go.
_____ 34. I do jobs or tasks automatically without being aware of what I'm doing.
_____ 35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.
_____ 36. I pay attention to how my emotions affect my thoughts and behavior.
_____ 37. I can usually describe how I feel at the moment in considerable detail.
_____ 38. I find myself doing things without paying attention.
_____ 39. I disapprove of myself when I have irrational ideas.

Mindfulness Questionnaire Scoring

Scoring the Five Facet Mindfulness Questionnaire
Ruth Baer, University of Kentucky
October 2005

Observe items:

1, 6, 11, 15, 20, 26, 31, 36

Describe items:

2, 7, 12R, 16R, 22R, 27, 32, 37

Act with Awareness items:

5R, 8R, 13R, 18R, 23R, 28R, 34R, 38R

Nonjudge items:

3R, 10R, 14R, 17R, 25R, 30R, 35R, 39R

Nonreact items:

4, 9, 19, 21, 24, 29, 33

The scores for each question are tallied in each category to determine a score for each facet of mindfulness. Scores for each category will then be added together to determine an overall mindfulness score.

Questions marked with an 'R' are reverse-scored, meaning that a score of a 4 ("often true") is reversed to a score of a 2 ("rarely true").

APPENIDIX D

Perceived Stress Assessment Instrument

Perceived Stress Scale

Perceived Stress Scale- 10 Item

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

1. In the last month, how often have you been upset because of something that happened unexpectedly?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

2. In the last month, how often have you felt that you were unable to control the important things in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

3. In the last month, how often have you felt nervous and "stressed"?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

4. In the last month, how often have you felt confident about your ability to handle your personal problems?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

5. In the last month, how often have you felt that things were going your way?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

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=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

7. In the last month, how often have you been able to control irritations in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

8. In the last month, how often have you felt that you were on top of things?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

9. In the last month, how often have you been angered because of things that were outside of your control?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

Perceived Stress Scale Scoring

PSS-10 scores are obtained by reversing the scores on the four positive items, e.g., 0=4, 1=3, 2=2, etc. and then summing across all 10 items. Items 4,5, 7, and 8 are the positively stated items.

The PSS was designed for use with community samples with at least a junior high school education. The items are easy to understand and the response alternatives are simple to grasp. Moreover, as noted above, the questions are quite general in nature and hence relatively free of content specific to any sub population group. The data reported in the article are from somewhat restricted samples, in that they are younger, more educated and contain fewer minority members than the general population. In light of the generality of scale content and simplicity of language and response alternatives, we feel that data from representative samples of the general population would not differ significantly from those reported below.

APPENIDIX E

Additional Results Tables

Table E1

MANOVA results for intervention-related changes in mindfulness

Test Name	Value	Exact *F*	Hypothesized *df*	Error *df*	Sig.
Pillais	.85042	66.80174	4.00	47.00	.000
Hotellings	5.68525	66.80174	4.00	47.00	.000
Wilks	.14958	66.80174	4.00	47.00	.000
Roys	.85042				

Table E2

MANOVA post hoc: Five facets of mindfulness paired samples t test ($p < .001$)

	Mean	Standard Deviation	Standard error of the mean	*t*	*df*	Sig.	*d*
Observe	2.137	3.688	.516	4.139	50	.000	.45
Describe	1.667	3.782	.530	3.147	50	.003	.40
Aware	2.941	4.370	.612	4.807	50	.000	.60
Nonjudging	3.451	3.668	.514	6.719	50	.000	.71
Nonreacting	2.647	2.726	.382	6.934	50	.000	.72
Overall	12.843	10.970	1.536	8.361	50	.000	.89

Table E3

Perceived stress paired samples t test ($p < .05$)

	Mean	Standard Deviation	Standard error of the mean	*t*	*df*	Sig.	*d*
Perceived stress	-4.686	5.409	.757	-6.187	50	.000	-.79

Table E4

Physical fitness measures paired samples t test ($p < .001$)

	Mean	Standard Deviation	Standard error of the mean	*t*	*df*	Sig.	*d*
Resting heart rate	-.824	8.258	1.156	-.712	50	.480	-.09
Predicted VO_2max	1.667	3.20633	.44898	3.725	50	.000	.24
Flexibility	2.941	5.43110	.76051	4.264	50	.000	.63
Balance	3.45	12.29197	1.72122	4.487	50	.000	.53