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## Abstract

**Background** Previous research reports positive effects of yoga on health. The physical and psychological outcomes of participation in Bikram yoga are under researched, despite its increasing popularity, and this type of yoga may be significant with regards to stress management due to its unique method of practice.

**Purpose** This study was designed to assess changes in levels of mindfulness, perceived stress, and physical fitness after participation in an 8-week Bikram yoga program.

**Methods** Fifty-one participants aged 20-54 years ( $M = 31.57$  years) were recruited by word of mouth from a large university located in the Northwestern United States. Participants attended a minimum of 20 Bikram sessions over 8-weeks. Changes in mindfulness (Five-Facet Mindfulness Questionnaire), perceived stress (Perceived Stress Scale), and physical fitness (resting heart rate, 1-mile walk, sit-and-reach, total-body rotation, and single-leg balance) were measured.

**Results** Eight weeks of Bikram yoga improved mindfulness, perceived stress, cardiorespiratory endurance, flexibility and balance ( $p < .01$ ). Mindfulness was negatively correlated with perceived stress ( $r = -.43, p < .01$ ) and resting heart rate ( $r = -.30, p < .05$ ).

**Conclusion** 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.

**Keywords:** Bikram yoga, mindfulness, perceived stress, cardiorespiratory fitness, flexibility, balance

## Introduction

Mindfulness is defined as the attention to and awareness of mind and body, accepting moment-to-moment experiences without judgment, and being present in a given moment (Kabat-Zinn 1990). To master mindfulness, the dissociation of oneself from one's reaction to an experience, an individual's focus changes from a reaction to the experience to a *reflection* about an experience (Bishop et al. 2004).

Mindfulness intervention programs (e.g. yoga) have been used to enhance the feeling of well being, alleviate stress, and improve psychological function (Carmody et al. 2009; Carmody & Baer, 2008; American Psychological Association, 2007). The mind-based stress reduction (MBSR) therapy model proposed by Kabat-Zinn utilizes 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. The main focus of Kabat-Zinn's MBSR and hatha yoga is the movement of the breath, which he describes as a constant, reliable focus to which individuals can return when attention is distracted. Awareness of the breath cycle, and attention to how it changes with the state of one's mind, cultivates a sense of control and power over the mind, as well as the physiological response of the body. As

participants move through the series of different asanas of hatha yoga, they are changing their inner focus with the physical changes of the body, using the breath--a true connection between mind and body.

Previous studies have reported that yoga has a positive effect on mood, stress, anxiety, depression, mindfulness, and other quality of life measures (Granath et al. 2006; Oken et al. 2006; Michalsen et al. 2005; Woolery et al. 2004). Certain styles of hatha yoga (e.g. Iyengar, Kundalini) have been tested as intervention and prevention techniques designed to minimize psychological distress and increase 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; Oken et al. 2006; Michalsen et al. 2005).

Bikram yoga, founded by Bikram Choudhury in the United States in 1973, is a form of hatha yoga that incorporates the same series of 26 asanas (including two breathing exercises) for every class (Choudhury 2007). Bikram is a physically and mentally challenging form of yoga due to the intensity of the 90 minute class that takes place in a heated room (i.e. 40.5°C [105° F]; 40% humidity). Instruction during class is continuous and based on a learned dialogue, highlighted by reminders to keep ones eyes open and focused on oneself in the front mirror in order to foster presence and mindfulness during the class. These unique environmental factors are thought to enhance mindful awareness of the movement of the body--reinforcing the mind-body, and allowing each individual develop awareness as his or her body is manipulated through the asanas.

Hart and Tracy (2008) study on the efficacy of Bikram yoga determined participants experienced changes in strength, steadiness, and balance after 24 sessions of Bikram yoga over an 8-week period. In the yoga group, knee extensor isometric strength and steadiness improved, especially for those who were less steady to start with, and balance improved significantly.

Participation in a Bikram yoga program may cultivate mindfulness through acute attention to mind-body connectedness, as well as improve one or more dimensions of physical fitness. In addition, 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. In light of the increasing popularity of Bikram yoga, and the limited research on it as an effective yoga practice, the purpose of this study was twofold: (a) to examine the effects of an 8-week Bikram yoga program on mindfulness, perceived stress and several components of physical fitness and (b) to examine the relationships between intervention-related changes in mindfulness with measures of perceived stress and physical fitness.

## Methods

### *Participants*

Eighty individuals were recruited via email and word of mouth from a large university located in the northwest portion of the United States. Participants completed an IRB approved consent form and were referred to a physician for clearance if they reported pre-existing conditions that might affect their participation in eight weeks of moderate to vigorous physical activity. Participants had not engaged in Bikram yoga on a long-term basis in the last two years, or at all during the 12 weeks prior to the study.

Of the 80 individuals who started the study, 51 participants completed the 8-week protocol (64% retention rate). Male ( $n = 10$ ) and female participants ( $n = 41$ ) between 20-54 years of age ( $M = 31.57$  years,  $SD = 9.29$ ) were asked to attend as many Bikram yoga sessions per week as desired with a goal of three sessions per week (i.e. 24 sessions total). When compared to completers, dropouts were significantly younger and more likely to be from a minority group. The main reason people dropped out was because of time commitments.

## Measures

Participants completed a consent form, medical questionnaire, sociodemographic questionnaire (e.g. ethnicity, yoga experience, and education) and a physical activity readiness questionnaire (PAR-Q). Participants were also asked about their activity levels outside of Bikram yoga over the 8-week period. Participants also completed two psychological questionnaires to evaluate pre- and postintervention levels of perceived stress and mindfulness:

The *Five Facet Mindfulness Questionnaire* (FFMQ) was used to measure mindfulness (Baer et al. 2006). The FFMQ measures mindfulness on five interrelated subscales: observing, describing, acting with awareness, nonjudging of inner experience, and nonreactivity to inner experience. The survey consisted of 39 items with responses recorded on a 5-point Likert scale. A score for each subscale was tallied, and an overall mindfulness score was calculated. Higher scores indicated higher levels of mindfulness. Construct validity and inter facet correlations (.32 to .56) have been reported for this measure (Baer et al. 2008).

The *Perceived Stress Scale* (PSS) was used to measure stress (Cohen & Williamson 1988; Cohen et al. 1983). High scores indicate a higher level of perceived stress. Internal reliability (.78) of the 10-item PSS scale is comparable to its 14-item scale predecessor (Cohen & Williamson 1988).

Participants were asked also to complete five measures related to physical fitness. Resting heart 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 addition, body mass (kg) was collected with a calibrated digital scale to use in the submaximal oxygen consumption (VO<sub>2</sub>max) prediction equations. Participants completed the Rockport One-Mile Fitness Walking Test on an indoor track in order to measure intervention-related changes in cardiorespiratory endurance using predicted VO<sub>2</sub>max values (American College of Sports Medicine [ACSM], 2006). Participants wore Polar heart rate monitors (A1 model, Lake Success, NY) and at the completion of the test, heart rate and time to complete the 1.0-mile walk were recorded. For college-age participants (18-30 years,  $n = 23$ ), VO<sub>2</sub>max was predicted using the Rockport One-Mile Fitness Walking Test equation developed by Dolgener et al. (1994). For participants over the age of 30 ( $n = 28$ ) the equation developed by Kline et al. (1987) was used to estimate VO<sub>2</sub>max.

In addition to the assessments listed above, three random participants were outfitted with Polar heart rate monitors during two Bikram yoga sessions to measure in-session heart rate to examine exercise intensity. A moderate to vigorous intensity training zone for cardiorespiratory exercise (50-85% heart rate reserve) was calculated for these participants using his or her resting heart rate and age (ACSM, 2006). The time spent in this heart rate zone was calculated for descriptive data analysis.

A single-leg balance test was used to measure balance (Hoeger & Hoeger 2010). Participants balanced as long as possible, until the heel of the standing foot touched the ground, the supported leg came free, or the hands left the hips. When necessary, the test was terminated after one minute on either leg. The best time of two trials on each leg was recorded. This test demonstrates face validity and is recommended by experts as a test of balance (Hoeger & Hoeger 2010).

Hamstring flexibility was assessed using Accuflex I Sit-and-Reach box and modified sit-and-reach test protocol (Hoeger & Hoeger 2010). An average of two trials was recorded in inches. Minkler and Patterson (1994) reported correlations to criterion measures (i.e. passive hamstring stretch and measure of anterior spine flexion) for both men and women ( $r = 0.75$ ;  $r = 0.66$ , respectively).

Transverse trunk and upper body flexibility was measured using the Accuflex II Body Rotation Flexibility Tester and a total-body rotation test protocol (Hoeger & Hoeger 2010). The average of both trials on each side was recorded in inches. This test demonstrates face validity and is recommended by experts as a test of flexibility (Hoeger & Hoeger 2010). Scores obtained in the sit-and-reach and the total body-rotation tests were combined to form one flexibility score recorded in inches. The first author and two graduate students who were trained in the testing techniques collected data for all tests. The same individuals collected pre- and postintervention data.

Qualitative data were noted informally by the first author. Although no qualitative data were analyzed, some interesting trends were observed which acknowledge the potential value of using a mixed-methods approach in future research.

### *Procedures*

Potential participants attended an informational meeting to learn about the study, sign a consent form, and complete demographic and medical questionnaires. Preintervention measurements took place in the Human Performance Lab at the university at a subsequent meeting.

Participants completed the FFMQ and PSS after arriving at the Human Performance Lab; then rested in a supine position for five minutes. Resting data were collected starting with resting heart rate followed by body mass (kg). Participants then warmed up by walking for five minutes on the treadmill, and stretching their hamstrings and lower back. Nonfatiguing tests (i.e. flexibility and balance) were completed next with the one-mile walk was completed last.

Participants started their 8-week program within two weeks of their preintervention testing session. The intervention sessions took place at a local Bikram yoga studio where weekly attendance was monitored by the first author. Participants were encouraged to attend as many sessions per week as they desired; however, they were required to attend at least 80% of the minimum 24 total sessions over the course of eight weeks (i.e. 20 of 24 sessions) to be included in the study results.

Postintervention testing took place within one week of the completion of the 8-week program as close as logistically possible to the same time of the day that the initial testing session took place and followed the same protocol as for the preintervention testing session.

### *Statistical Analyses*

Descriptive statistics were generated for demographic characteristics of the sample collected from the demographic questionnaire. A multivariate analysis of variance (MANOVA) was used to examine the pre- and postintervention changes in mindfulness. Bonferroni correction was used to adjust for the significance levels when individual subscales of mindfulness were compared using paired t-tests. A series of paired t tests was also used to examine pre- and postintervention changes in perceived stress, balance, flexibility, resting heart rate, and predicted VO<sub>2</sub>max scores with Bonferroni correction for the significant levels. Pearson's correlation coefficients were used to observe relationships between the intervention-related changes in mindfulness and the changes in each of the following components: perceived stress, resting heart rate, predicted VO<sub>2</sub>max, balance, and flexibility. Effect sizes were also calculated for each outcome variable. All statistical analyses were computed using SPSS 18.0 (SPSS Inc. Chicago, IL).

## **Results**

Participants ( $N = 51$ ) were predominantly female (80%), of Caucasian descent (94.1%), with at least some college education (92.2%). Age ranged from 20-54 years ( $M = 31.57$ ,  $SD = 9.29$ ). Average attendance over the 8-week period was 28.59 sessions ( $SD = 9.21$  sessions). The majority of the sample had meditative experience (53%) or yoga experience (80%) and 27% had tried Bikram yoga previously. A proportion of participants (20%) were engaging in exercise at the start of the study, mostly in cardiorespiratory fitness activities and weight training (47%) for 60 minutes or less (59%) at a frequency of four or fewer times per week (75%).

Table 1 illustrates that participation in an 8-week Bikram yoga program increased overall mindfulness, Hotelling's  $T = 5.69$ ,  $F(4, 47) = 66.80$ ,  $p < .01$ ,  $d = .89$ , lowered perceived stress,  $t(50) = 6.19$ ,  $p < .01$ ,  $d = -.79$ , and did not change resting heart rate,  $t(50) = 0.71$ ,  $p = .24$ ,  $d = -.09$ . In addition, the intervention improved predicted VO<sub>2</sub>max,  $t(50) = 3.73$ ,  $p < .01$ ,  $d = .24$ , flexibility,  $t(50) = 11.48$ ,  $p < .01$ ,  $d = .63$ , and balance,  $t(50) = 4.51$ ,  $p < .01$ ,  $d = .53$ .

**[Insert Table 1 here]**

Correlations between changes in mindfulness and all other measured variables were examined. Changes in overall mindfulness were significantly correlated only with changes in perceived stress ( $r = -.43, p < .05$ ) and resting heart rate ( $r = -.30, p < .01$ ).

As a manipulation check, three participants ranging in age from 22-23 years were asked to monitor heart rate data during two Bikram yoga sessions to assess level of intensity while involved in instruction. The average time spent in the target heart rate range (i.e. exercise intensity between 50-85% of heart rate reserve) for two sessions was 47 minutes ( $\pm 16$ ), which was 44% of the 90-minute session.

## Discussion

This study examined the psychological and physical effects of an 8-week Bikram yoga program in an apparently healthy population of young, mostly female, well-educated adults. The first major finding supported the notion that an 8-week Bikram yoga program increased overall mindfulness and all five subscales of mindfulness significantly. Our findings are consistent with previous studies that observed changes in mindfulness after participation in other mind-based stress-reduction programs (Carmody et al. 2009; Carmody & Baer 2008; Granath et al. 2006). The current study suggests that Bikram yoga alone may be effective for improving mindfulness when compared to programs combining yoga with other techniques for the purpose of mindfulness-training based stress reduction.

Another positive effect of Bikram yoga was the significant reduction in perceived stress. These findings are consistent with several studies that employed a variety of intervention protocols shown to reduce perceived stress (Carmody et al. 2009; Granath et al. 2006; Woolery et al. 2004). Hence, Bikram yoga shows promise as a form of mind-based exercise that decreases perceived stress.

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 negative correlation ( $r = -.43, p < .01$ ) between mindfulness and perceived stress in the current study allows for further insight into how we can better regulate our reactions to unavoidable stressful events when we cultivate our inherent ability to be mindful. The findings from this study suggest that Bikram yoga might provide the necessary tools to cultivate mindfulness in stressful situations, which in turn decreases perceived stress. Changes in resting heart rate were also correlated negatively with changes in mindfulness ( $r = -.30, p < .04$ ), suggesting that more mindful participants were more mindful of the calming effect they can have on the sympathetic nervous system.

A third major finding is that predicted  $VO_2\max$  may have improved as a result of this Bikram yoga program. This finding should be viewed with caution, however, since a small proportion of the participants engaged in aerobic exercise in addition to Bikram yoga. Our findings are in contrast to Clay et al. (2005) who determined that hatha yoga did not elicit *metabolic* workloads that met ACSM's exercise intensity guidelines for aerobic exercise prescription. The potential to improve aerobic fitness with Bikram yoga offers promise, however, especially given the importance of aerobic fitness to general health (see ACSM, 2006). The observed elevated heart rate during Bikram yoga, likely a result of both the heated room and the asanas, might lead to cardiovascular benefits that are commonly associated with aerobic exercise. Bikram yoga is a nonimpact exercise that, with further research (e.g. heart rate and metabolic cost data), may be considered comparable to traditional aerobic exercise. This finding means that those unable to participate in traditional, aerobic exercise due to injury might still be able to achieve cardiorespiratory improvements through Bikram yoga.

Flexibility significantly improved with participation in eight weeks of Bikram yoga. Mobility might better describe the possible effects rather than flexibility, as increases in strength combined with increases in flexibility could be responsible for changes in the flexibility score rather than flexibility alone.

Balance improved after eight weeks of Bikram yoga. Our results are consistent with the findings of Hart and Tracy (2008), who suggested three possible contributions to this improvement: the control of the breath, which may increase steadiness while balancing, improved muscular endurance and improved proprioceptive awareness.

In addition to the quantitative measurements, qualitative feedback was informally noted. After the 8-week study some participants reported better quality of sleep, and others reported that their clothes fit better. Future studies should include measures of body composition to continue to assess the benefits of Bikram yoga.

Despite the positive and noteworthy findings, there are some limitations associated with this study. The sample 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. Also, the results of this study can be generalized only to healthy, Caucasian adults (with females overrepresented) aged between 20 and 54 years old who have at least some college education.

Limitations of the study design included the absence of a control group and the choice of field tests and questionnaires that were used to measure changes in physical fitness and psychological health. The psychological questionnaires could have unfairly represented intervention-related changes in mindfulness and perceived stress due to the time at which they were taken.

It is important to consider several future directions that would enable us to deepen our understanding of the potential mind and body benefits of engaging in Bikram yoga. Future studies with Bikram yoga should incorporate a control group, and even a second physically active experimental group in order to compare Bikram yoga to other modes of exercise. 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 type of investigation could reveal valuable information that would assist in recommending a minimum weekly health-enhancing prescription of Bikram yoga. An additional recommendation is the measurement of qualitative outcomes after participation in Bikram yoga. As shown informally by this study, Bikram yoga affected participants' lives beyond that which the instruments in this study could measure. Additional quantitative measures might include muscular strength and endurance, body composition, and the metabolic costs of Bikram yoga. Additional suggestions for future research include: (a) using a different predictive  $VO_2$ max test and/or a maximal effort  $VO_2$ max test based on the starting fitness level of the sample population, (b) collecting heart rate data from all participants in Bikram yoga classes, as well as noting the resting heart rate in the yoga room to help control for the contribution of the heat to the increased heart rate during class, and (c) using additional measures of stress (e.g. cortisol) to confirm the questionnaire results.

This study generates a starting point for measuring psychological health and physical fitness together in relation to mind-body exercise interventions. Due to the positive findings in this study there is a need to continue to research the effects of Bikram yoga and how it increases mindfulness, reduces stress and potentially lessens the risk of stress-related illnesses. The Bikram yoga environment encourages the class to stay present with their experience, enhancing mind-body awareness, which may mediate the stress response during stressful events. It is also important to continue to examine Bikram yoga as a means to improve components of health-related fitness (e.g. cardiorespiratory fitness). The current state of human well-being, as expressed by the high incidence of stress-related illnesses and inactivity, suggests that future research is vital for a deeper medical understanding and appreciation for Bikram yoga.

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Table 1

*Changes in Mindfulness, PSS and Physical Fitness Variable*

Characteristic	Assessments		Change (M)
	Pre (M ± SD)	Post (M ± SD)	
Mindfulness			
<i>Observe</i>	29.06 ± 5.31	31.20 ± 4.14	+2.14*
<i>Describe</i>	29.16 ± 4.21	30.82 ± 4.19	+1.66*
<i>Awareness</i>	24.94 ± 5.21	27.88 ± 4.52	+2.94*
<i>Nonreactive</i>	22.10 ± 3.75	24.75 ± 3.65	+2.65*
<i>Nonjudging</i>	26.84 ± 4.85	30.29 ± 4.81	+3.45*
<i>Total</i>	132.10 ± 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 <sub>2</sub> max (ml·kg <sup>-1</sup> ·min <sup>-1</sup> )	38.44 ± 7.07	40.12 ± 7.15	+1.68*
Flexibility (cm)	32.74 ± 17.40	41.00 ± 27.03	+8.26*
Balance (secs)	10.64 ± 10.81	18.36 ± 18.37	+7.72*

\*  $p < .01$ .

*Notes:* 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.

Flexibility scores were recorded in inches but have been reported above in centimeters.