



HUMAN PHYSIOLOGY STUDY

# The effect of Bikram yoga on endothelial function in young and middle-aged and older adults



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## KEYWORDS

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**Summary** The purpose of this investigation was to determine if Bikram yoga, a style of heated hatha yoga, would improve endothelial function in young and middle-aged and older, healthy adults. This trial was performed in 36 young ( $n = 17$ ) and middle-aged and older adults ( $n = 19$ ) who completed 3 weekly Bikram yoga classes for 8 weeks. Height, body weight and body composition were determined and endothelial function was measured noninvasively using brachial artery flow-mediated dilation (FMD) before and after the intervention. No changes in body weight, BMI or body fat percentage occurred as a result of the intervention in either group. Brachial artery FMD was significantly increased in middle-aged and older ( $P < 0.05$ ) but not in young adults as a result of the intervention. The results demonstrate that a relatively short-term Bikram yoga practice might significantly improve vascular endothelial function in middle-aged and older adults. While apparently healthy individuals in this study experienced no adverse events, those with preexisting conditions should take caution and consult with a physician prior to engaging in this style of yoga.

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**Abbreviations:** BMI, Body mass index; FMD, flow-mediated dilation.

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## Introduction

Endothelial dysfunction is a disruption in vascular homeostasis resulting in an increased risk of cardiovascular disease and its associated events (Chan et al., 2003). Endothelial dysfunction occurs with advancing age and has been shown to improve with traditional endurance exercise (DeSouza et al., 2000; Nualnim et al., 2012). Yoga may present a feasible alternative to traditional exercise in older adults given the low-impact and low joint stress nature of this activity. We have previously reported that hatha (non-heated) yoga, the most widely practiced form of yoga in the U.S., was not effective in improving vascular function (Hunter et al., 2013c).

Bikram yoga is a rigorous yoga style practiced in a heated environment (41 °C) with 40–60% of relative humidity. As repeated thermal therapy consisting of sauna treatment improves endothelial function (Ohori et al., 2012), it is conceivable that Bikram yoga, which exposes the vasculature to heat stress in addition to exercise may be beneficial in improving vascular function. While few studies have demonstrated beneficial effects of Bikram yoga on glucose tolerance in older, obese adults (Hunter et al., 2013a) along with enhancements in arterial compliance in young adults (Hunter et al., 2013b), no studies have investigated the effect of Bikram yoga on endothelial function. Therefore, the primary aim of the present study was to determine if Bikram yoga would improve endothelial function. As Bikram yoga is practiced widely across all ages, we evaluated the effects of Bikram yoga in young and older subjects.

## Materials and methods

### Participants

Potential subjects were recruited via local yoga studio newsletters and campus flyers. A total of 47 participants varying widely in age from 18 to 70 years were enrolled. All subjects were apparently healthy, sedentary, defined as exercising less than one hour per week during the prior 6 months, free of overt cardiovascular disease (CVD) and were nonsmokers at the time of the study. Exclusion criteria included: pregnancy; uncontrolled hypertension; infection within the previous 4 weeks; renal disease; adrenal or endocrine tumors; prior myocardial infarction; known coronary artery disease; chronic heart failure; personal history of stroke or cardiac arrhythmias; diabetes; orthopedic injuries; and heat intolerance. Previous yoga exposure/practice was not an inclusion/exclusion criterion. But none of the subjects had practiced yoga regularly.

### Measures

Body composition was determined using dual-energy X-ray absorptiometry (GE Medical Systems, Fairfield, CT). Endothelium-dependent vasodilation was determined non-invasively using brachial artery flow-mediated dilation (FMD) (Eskurza et al., 2005; Harrison et al., 2011). For the FMD measurement, a pressure cuff placed around the subject's forearm was inflated after baseline longitudinal

brachial artery images were obtained 5–10 cm proximal to the antecubital fossa via ultrasound. The cuff was inflated to 100 mmHg above systolic blood pressure for 5 min, and more brachial artery images were obtained after cuff deflation and analyzed using the Brachial Analyzer Software (Vascular Tools, Medical Imaging Application, Coralville, Iowa). Flow-mediated dilation was calculated as the percent change in arterial diameter from an average of 10 baseline diastolic diameters and the average of three maximal diastolic diameters.

All testing was performed after subjects had fasted for at least 4 h and abstained from caffeine for 12 h and from vitamin C, E, and  $\alpha$ -lipoic acid supplementation at least 3 days prior to testing. All vascular measurements were performed at the same time of day before and after the intervention to avoid diurnal changes, and after the subject had rested in the supine position for at least 15 min in a quiet, temperature-controlled room. All but one of the premenopausal female subjects were tested during the follicular phase of their menstrual cycle to avert the influence of estrogen and progesterone on outcome measures. One subject was tested during the luteal phase before and after the intervention. The intervention durations were slightly modified to control for menstrual cycle phase for premenopausal women and the actual intervention range was 51–64 days.

### Intervention

The yoga intervention consisted of 8 weeks of 3 weekly 90-min Bikram yoga classes. All classes included the standard 26-posture Bikram yoga series and were taught by certified Bikram yoga instructors and completed at local yoga studios in Austin, TX with standardized instruction and regimented heat (41 °C) and humidity (40–60% relative humidity). All participants were instructed not to alter their diet or engage in other forms of exercise during the intervention to prevent the potentially confounding effect of these variables on endothelial function.

The present study was approved by the Institutional Review Board at the University of Texas at Austin and performed in accordance with the ethical standards laid down in the Declaration of Helsinki. Written informed consent was obtained from all subjects.

### Statistical analysis

Continuous variables were presented as means  $\pm$  standard error of the mean (SEM). Data distribution normality was verified using the Shapiro–Wilk test. To explore the influence of age on changes in our key variable of interest, brachial artery FMD, a repeated measures ANOVA was performed. ANOVA was used to perform baseline comparisons between age groups, and repeated measures ANOVA was utilized to evaluate changes in dependent variables as a result of the intervention. Values of  $p \leq 0.05$  were considered statistically significant. Statistical Package for Social Sciences (SPSS, Chicago, IL, USA Version 20.0) was used to prepare the database and for statistical analysis.

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