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PILOT STUDY

Improvements in glucose tolerance with Bikram yoga in older obese adults: A pilot study

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Abstract Bikram yoga is an exotic form of physical activity combining hatha yoga and thermal therapy that could positively impact metabolic health. Although this increasingly popular alternative exercise may be ideal for obese adults due to its low impact nature, few studies have elucidated the health benefits associated with it. As an initial step, we determined the effect of Bikram yoga on glucose tolerance. Fourteen young lean and 15 older obese subjects completed an 8-week Bikram yoga intervention in which classes were completed 3 times per week. Glucose tolerance was assessed using a 75 g oral glucose tolerance test. The area under the glucose curve following the oral glucose tolerance test was significantly reduced as a result of the Bikram Yoga intervention in older obese ($P < 0.05$) but not in young lean subjects. We concluded that a short-term Bikram yoga intervention improved glucose tolerance in older obese, but not in young lean adults.

Introduction

Bikram yoga is a trademarked form of hatha yoga in which 26 postures are performed in a heated sauna-like environment (40.5 °C with 40–60% relative humidity) over a 90-min period to scripted instruction. Although this so-called "hot yoga" is rapidly spreading and now widely used, very few experimental studies have determined the health benefits associated with it.

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Impaired glucose tolerance is a manifestation of insulin resistance associated with aging (Defronzo, 1981) and obesity (Reaven et al., 2004) that could be ameliorated with Bikram yoga. Currently, there is no information on the effect of *Bikram yoga* on glucose tolerance or insulin resistance. There are a limited number of research studies employing non-heated (standard) hatha yoga variations but the results are conflicting as some studies reported improvements in glucose tolerance (Jain et al., 1993, Malhotra et al., 2002) while others showed no effect of hatha yoga (Cade et al., 2010, Dipietro et al., 1998).

A hallmark feature of Bikram yoga is the sauna-like environment in which it is practiced. Studies have shown reductions in fasting blood glucose (Imamura et al., 2001) and hemoglobin A1c (Hooper, 1999) in humans and attenuations in high-fat diet-induced glucose intolerance in animals (Gupte et al., 2009) with thermal therapy, improvements which have been attributed to increases in heat shock protein levels (Gupte et al., 2010). Arguably, the combined effect of thermal and hatha yoga therapies employed with Bikram yoga will have a greater impact on glucose tolerance if such effect exists. However, to date, no studies have addressed this aim.

Accordingly, the aim of the present study was to determine the effect of a *Bikram yoga* intervention on glucose tolerance. In order to address the effect of *Bikram yoga* in adults at low vs. high risk of developing metabolic diseases, young lean adults and older obese subjects were studied. We hypothesized that Bikram yoga would improve glucose tolerance to a greater extent in older obese than in young, lean adults based on the previously cited findings of changes in glucose tolerance with yoga practice in diabetic patients (Jain et al., 1993, Malhotra et al., 2002) but not in nondiabetic adults (Cade et al., 2010).

Methods

Fourteen young, lean (3 male) and 15 older, obese (3 male) subjects were recruited and enrolled in the *Bikram yoga* intervention. Lean and obese subjects had BMI values of 18.5—24.9 kg/m^2 and >30 kg/m^2, respectively. Exclusion from the study was based on the following criteria: smoking within the last 6 months; uncontrolled diabetes (chronic hyperglycemia while on diabetic medications); personal history of stroke; prior myocardial infarction; and known coronary artery disease. All subjects engaged in <2 days/week of physical activity for the past 6 months. All human studies have been approved by the University of Texas at Austin ethics committee and have therefore been performed in accordance with the ethical standards laid down in the Declaration of Helsinki.

The 90-min *Bikram yoga* classes were performed 3 times per week for 8 weeks at local *Bikram yoga* studios in which rooms were heated to 40.5 °C accompanied by a 40—60% relative humidity. Classes consisted of 26 yoga postures or poses performed to scripted (standardized) instructions. During the intervention, subjects were instructed not to alter their usual diet and not to engage in other forms of physical activity.

Body composition was determined via dual-energy X-ray absorptiometry (GE Systems, Fairfield, CT). Two-hour oral glucose tolerance tests were administered after 12 h of fasting. Subjects ingested a 75 g glucose solution and blood samples were obtained at 30-min intervals and analyzed using the enzymatic glucose hexokinase method. Glucose area under the curve was determined using the trapezoid method. Testing was performed a minimum of 48 h after the final Bikram yoga session to avoid any acute (residual) effects of yoga.

Data in Table 1 are presented as means ± SD and data in the figure are presented as means ± SEM. One-way ANOVA and ANOVA with repeated measures were used to analyze baseline and intervention results, respectively.

Results

As shown in Table 1, older obese subjects were significantly older and had greater body mass, BMI, and body fat percentage than young lean subjects (all $P < 0.05$). There were no changes in body mass and body composition in young lean subjects. In older obese subjects, small but significant reductions in body mass and BMI were observed though body fat percentage did not change. At baseline, the total area under the glucose curve was not significantly different between lean and obese subjects ($P = 0.258$). There were no alterations in fasting plasma glucose in either group as a result of the intervention. The area under the glucose curve was significantly reduced in older obese subjects ($P < 0.05$), but was unaltered in young lean subjects (Fig. 1).

Discussion

We found that the relatively short-term *Bikram yoga* intervention improved glucose tolerance in older obese

Table 1 Selected subject characteristics.

	Young lean		Older obese	
	Before	After	Before	After
Age (yrs)	32 ± 10	—	46 ± 12†	—
Height (cm)	167 ± 8	—	169 ± 7	—
Body mass (kg)	61.5 ± 7.5	62.2 ± 7.3	98.3 ± 16.1†	97.1 ± 16.2*
BMI (kg/m^2)	22.1 ± 2.1	22.2 ± 2.0	34.3 ± 4.7†	33.7 ± 4.9*
Body fat (%)	28 ± 9	28 ± 9	44 ± 6†	44 ± 6
Lean body mass (kg)	44.4 ± 7.1	44.9 ± 7.1	55.1 ± 11.0†	54.2 ± 9.0

Data are presented as means ± SD.
*$P < 0.05$ vs. Before, †$P < 0.05$ vs. Young lean.