Complementary Therapies in Medicine 29 (2016) 169–174

Contents lists available at ScienceDirect

Complementary Therapies in Medicine

journal homepage: www.elsevierhealth.com/journals/ctim

Differences in energy expenditure during high-speed versus standard-speed yoga: A randomized sequence crossover trial

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ARTICLE INFO

Article history:
Received 15 July 2016
Received in revised form
29 September 2016
Accepted 4 October 2016
Available online 15 October 2016

Keywords:
Yoga
Power yoga
Energy expenditure
Oxygen consumption

ABSTRACT

Objectives: To compare energy expenditure and volume of oxygen consumption and carbon dioxide production during a high-speed yoga and a standard-speed yoga program.
Design: Randomized repeated measures controlled trial.
Setting: A laboratory of neuromuscular research and active aging.
Interventions: Sun-Salutation B was performed, for eight minutes, at a high speed versus and a standard-speed separately while oxygen consumption was recorded. Caloric expenditure was calculated using volume of oxygen consumption and carbon dioxide production.
Main outcome measures: Difference in energy expenditure (kcal) of HSY and SSY.
Results: Significant differences were observed in energy expenditure between yoga speeds with high-speed yoga producing significantly higher energy expenditure than standard-speed yoga (MD = 18.55, SE = 1.86, $p < 0.01$). Significant differences were also seen between high-speed and standard-speed yoga for volume of oxygen consumed and carbon dioxide produced.
Conclusions: High-speed yoga results in a significantly greater caloric expenditure than standard-speed yoga. High-speed yoga may be an effective alternative program for those targeting cardiometabolic markers.

1. Introduction

The practice of yoga originated over 5000 years ago in India.[1] with the overarching goal of aligning the mind and body. It challenges both the physical and mental capacity of its participants by including different poses (asanas), breathing exercises (pranayama), meditation techniques, and mantras [2] Recently, the practice of yoga has emerged as a popular and effective exercise modality. The National Center for Health Statistics reported that the use of yoga in adults aged 18 and over linearly increased from 5.1% in 2002 to 6.1% in 2007, and then to 9.5% in 2012.[3] Additionally, over 57.4% of adults who use complementary and alternative medicine reported using yoga as a method for weight control.[4]

Hatha yoga or standard-speed yoga (SSY), one of the most popular yoga forms, is the foundation of all yoga styles. It concentrates on achieving enlightenment and/or self-realization while physically challenging the body. Hatha yoga has become very popular in the United States as both a source of stress management and physical activity. The benefits of classic yogic training include improvements in body composition,[5,6] muscle strength, power and endurance,[7,8] flexibility,[9,10] and balance and coordination.[11] Additionally, yoga is an attractive alternative to aerobic and strength training because it is inexpensive requiring limited equipment and little space. Another variation of yoga, Power Vinyasa yoga or high-speed yoga (HSY), has become an increasingly popular training modality. Power yoga is characterized by faster transitions from one posture to another and poses held for a shorter duration than Hatha yoga.[12] HSY has been shown to be effective in improving balance,[13] and alleviating motor symptoms in patients with musculoskeletal disorders.[14]

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http://dx.doi.org/10.1016/j.ctim.2016.10.002
0965-2299/

In addition to the many benefits of yoga, both HSY and SSY have become widely utilized and effective tools for weight management and weight loss in healthy populations, persons with diabetes,[15] cardiovascular disease risk,[16] and hypertension.[17] Kristal et al.,[6] reported that practicing yoga over a 10 year period attenuated weight gain in a large cohort of men and women aged 53 to 57 years old. They also found that practicing yoga was associated with higher odds of weight loss; however, they could not differentiate between the different types of yoga practice and their varying intensities in relation to their relative impacts on weight maintenance or loss.

Despite the use of yoga as a popular source of exercise and the numerous benefits obtained by practicing yoga, there have been, to our knowledge, no studies investigating the difference in energy expenditure (EE) during HSY compared to SSY. Several studies have investigated static poses and breathing exercises.[18–20] and concluded that Hatha yoga does not reach a high enough intensity to adequately address weight management or weight loss according to the American College of Sports Medicine (ACSM) guidelines.[21] Additionally, there are no current studies investigating the impact of HSY on aerobic capacity.

Knowing the difference in EE and oxygen consumption (VO_2) during HSY versus SSY will help instructors, practitioners, researchers, and healthcare providers better understand which types of yoga to practice and prescribe when faced with populations with varying cardiometabolic needs. Therefore, the purpose of this study was to compare the difference in EE of HSY and SSY. Additionally, VO_2 and the volume of carbon dioxide (VCO_2) produced during exercise and during excess post-exercise oxygen consumption (VO_{2EPOC}, VCO_{2EPOC}) between HSY versus SSY. We hypothesized that HSY would produce greater EE than SSY. We also hypothesized that HSY would require greater VO_2, VO_{2EPOC}, VCO_2, and VCO_{2EPOC} compared to SSY. As a complementary and secondary measure, we evaluated the difference in muscle activation between HSY and SSY. This analysis can be found in a separate article.

2. Methods

2.1. Design

This study used a randomized repeated measures controlled trial design. Subjects were recruited from the University's Wellness Center and local yoga studios. All testing was conducted at the Laboratory of Neuromuscular Research and Active Aging. Subjects attended three testing sessions. On day one documents were completed, anthropometric measures taken and maximal oxygen consumption assessed. On days two and three, VO_2 was evaluated during HSY or SSY. The order was randomized to reduce order or learning effects. Participants underwent a ten hour fast and abstained from exercise for 24 h prior to each testing session to reduce the impact of diet and previous activity on VO_2, VCO_2 and subsequent computation of EE. All testing sessions were completed within a two week period and each lasted approximately one-hour. This study was approved by the University's Subcommittee for the Use and Protection of Human Subjects and is registered on ClinicalTrials.gov (NCT02818881).

2.2. Participants

Twenty-two adults (16 Women, 29.9 ± 5.85 years, 6 Men, 33.17 ± 16.30 years) with at least one year of yoga experience, currently practicing a minimum of two hours a week, and demonstrating good form in the Sun-Salutation poses (asanas), were included in this study. Form was evaluated by one of the researcher (KM) with over 15 years of yoga teaching experience. Exclusion criteria included: uncontrolled neuromuscular, orthopedic, and/or cardiovascular disease and advisement from their physician to abstain from exercise. All participants signed a written informed consent approved by the University's Human Subjects' Subcommittee.

Table 1
Sun Salutation B poses .

1. Mountain pose with arms down (Tadasana)
2. Chair (Utkaasana)
3. Forward fold (Uttanasana)
4. Halfway lift (Urdhva Mukha Uttanasana)
5. High plank (Dandasana)
6. Low plank (Chaturanga Dandasana)
7. Upward facing dog (Urdhva Mukha Svanasana)
8. Downward facing dog (Adho Mukha Svanasana)
9. Right side warrior 1 pose (Virab-hadrasana I)
10. High plank (Uttihita Chaturanga Dandasana)
11. Low plank (Chaturanga Dandasana)
12. Upward facing dog (Urdhva Mukha Svanasana)
13. Downward facing dog (Adho Mukha Svanasana)
14. Left side warrior 1 pose (Virab-hadrasana I)
15. Mountain pose with arms down (Tadasana)

2.3. Indirect calorimetry

Expired air was collected using a portable ergospirometry device which was calibrated prior to each testing session (Oxycon Mobile, Hoechberg, Germany). A two-way non-rebreathing nasal and mouth face mask was fitted to each subject to prevent air leakage. Expired air was collected during a 10-min resting phase prior to testing, an eight-minute testing session, and a 15-min excess post-exercise oxygen consumption (EPOC) resting phase. The metabolic unit exported collected data to an excel document in 10 s intervals for the duration of the session. These data were later used to calculate total EE (kcals) using VO_2 and VCO_2. EE from indirect calorimetry was calculated using the equations derived by Jeukendrup et al.[22]

2.4. Conditions and test sessions

2.4.1. Yoga sequence

The poses of Surya Namaskar (sun salutation) B are presented in Table 1. Each transition and pose of the Sun Salutation B sequence was set to a metronome. The time between pose transitions was 3 s and 12 s for the HSY and the SSY, respectively. Subjects were given the opportunity to familiarize themselves with performing the sequence at the pace of the metronome before the testing. Subjects were instructed to repeat the sequence with good form continuously for the eight minutes of testing. While the SSY program may have arguably targeted both isometric strength and flexibility, the HSY program was designed to replicate the work:recovery duty cycles typical of a high-intensity interval program.

2.4.2. Day 1

On the first day of testing, subjects completed an informed consent, a standard health status questionnaire, and a yoga self-assessment questionnaire. Height and weight were then recorded using a standard medical scale (Detecto 439 Beam Scale, Detecto Corp., Webb City, MO). Subject completed a maximal oxygen consumption test (VO_{2max}) on a motorized Cybex 790T treadmill (Cybex International, Inc., Medway, MA. USA) and expired gas was continuously collected and analyzed using a portable breath-by-breath gas analyzer (Oxycon Mobile, Hoechberg, Germany). The testing protocol used was a modified version of the Astrand Treadmill Test.[23] Subjects completed a two-minute warm-up at a self-selected speed and a grade of 0%. After completing the warm-up, the subject was directed to select the fastest speed during which