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

Melanie Potiaumpai (MS)[a], Maria Carolina Massoni Martins[a], Roberto Rodriguez (BBA)[a], Kiersten Mooney (MS)[b], Joseph F. Signorile (Ph.D)[a,c,*]

[a] Laboratory of Neuromuscular Research and Active Aging, University of Miami, Department of Kinesiology and Sports Sciences, 1507 Levante Avenue, #123, Coral Gables, FL 33146, United States
[b] Green Monkey Yoga, 1430 S Dixie Highway, #116, Coral Gables, Miami, FL 33146, United States
[c] Miller School of Medicine, Center on Aging, University of Miami, 1695 N.W. 9th Avenue, Suite 3204, Miami, FL 33136, United States

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]

* Corresponding author at: 1507 Levante Ave., Rm 114, Coral Gables, FL 33146, United States.
E-mail addresses: m.potiaumpai@umiami.edu (M. Potiaumpai), carolmassonim@gmail.com (M.C.M. Martins), Robertr1008@gmail.com (R. Rodriguez), kiersten@greenmonkey.com (K. Mooney), jsignorile@miami.edu (J.F. Signorile).

http://dx.doi.org/10.1016/j.ctim.2016.10.002
0965-2299/© 2016 Published by Elsevier Ltd.

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

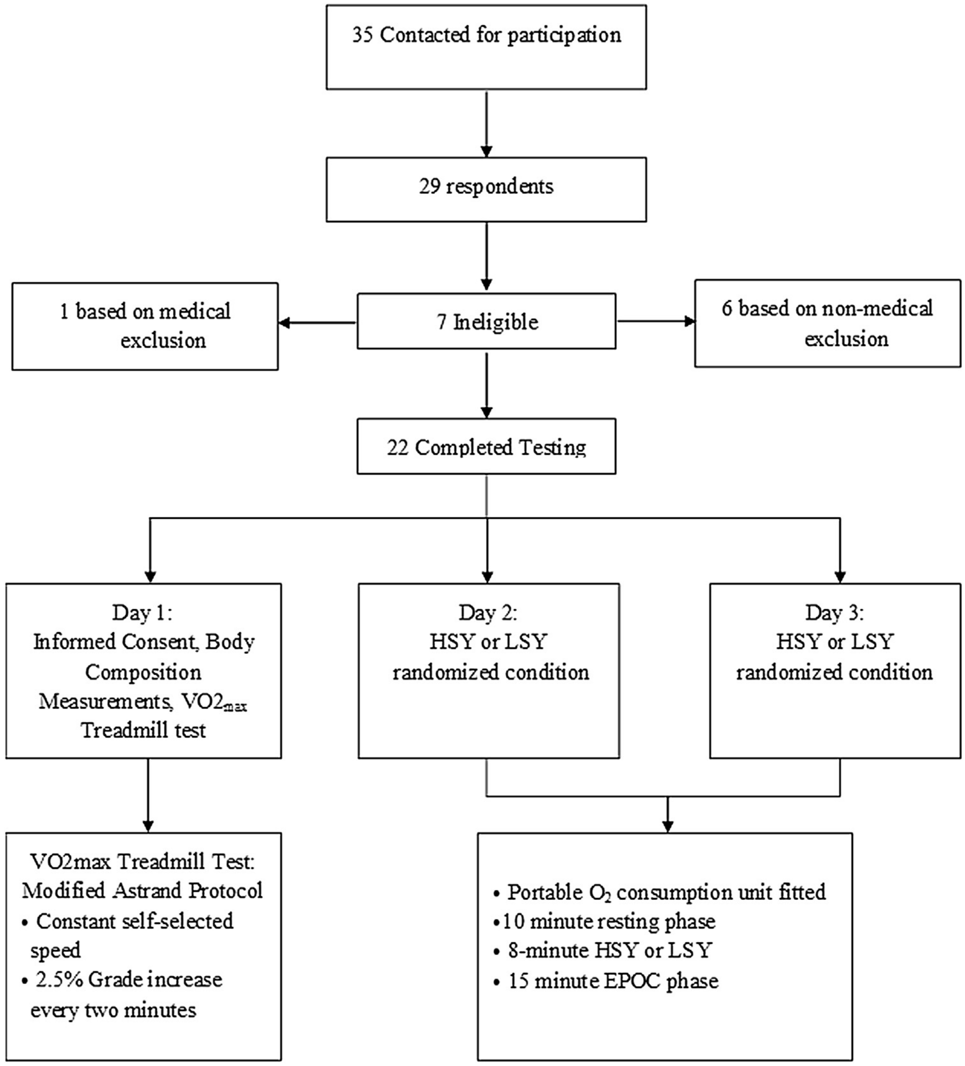

Fig. 1. Study design and participant flow through study.

he or she could maintain a conversation. This selected speed was kept constant throughout the remainder of the test. At the start of the test, the incline increased to 2.5% and was increased by 2.5% every two minutes until test completion. Perceived exertion was measured using the 15 point Borg Rating of Perceived Exertion (RPE) Scale.[24] Heart rate was monitored using a Polar T31 Coded Transmitter (Polar Inc., Lake Success, NY, USA). Established criteria from ACSM were used to determine maximal effort criteria and test termination.[25]

2.4.3. Days 2 and 3

Subjects reported to the laboratory for an additional two visits to complete either the HSY or SSY sequence, the order of which was randomly assigned using a random number generator. Subjects were instructed to fast at least 10 h before each session. Prior to donning the portable ergospirometry unit, subjects practiced the Sun-Salutation B sequence set to the appropriate metronome pace. Subjects were then fitted with the ergospirometry unit and lay in a supine position in a dark, quiet room for 10 min. Additionally, subjects were fitted with EMG electrodes to assess activity levels of eight selected muscles. The EMG protocol and analysis can be found in a separate article. Following this resting phase, the subject performed either the HSY or SSY sequence for eight minutes. Immediately following the yoga sequence, the subject again repeated the resting condition for 15 min, which constituted the EPOC phase.

2.5. Statistical analyses

The primary outcome measure was total EE (EE_T) (exercise and EPOC). Secondary outcome measures included VO_2 ($mL\,kg^{-1}\,min^{-1}$) and volume of carbon dioxide produced (VCO_2) ($mL\,kg^{-1}\,min^{-1}$) during exercise and during EPOC (VO_{2EPOC}, VCO_{2EPOC}).

Data were analyzed using a 2 (gender) × 2 (speed) repeated-measures ANOVA. These analyses were designed to examine the difference in EE between HSY and SSY and to detect any difference or interaction between men and women on EE. Significance was set *a priori* at $p \leq 0.05$.

3. Results

3.1. Participants

Sixteen women (29.9 ± 5.8 years) and six men (33.2 ± 16.3 years) completed all three testing sessions. Fig. 1 shows the study design and flow of participants through the study.

Participants' characteristics are presented in Table 2. No significant group difference was observed in age, sex, height, weight, or yoga experience.

Table 2
Participant Characteristics.

	Sample (n = 22)	Women (n = 16)	Men (n = 6)
Age (years)	29.5 ± 6.0	29.9 ± 5.85	33.17 ± 16.30
Height (m)	1.67 ± 0.10	1.63 ± 0.06	1.79 ± 0.08
Weight (kg)	64.71 ± 14.17	58.51 ± 1.82	81.26 ± 15.27
BMI (kg/m^2)	22.90 ± 2.83	22.09 ± 2.46	25.08 ± 2.76
Yoga Experience (years)	5.07 ± 3.82	5.94 ± 4.09	2.75 ± 1.48

Values are Mean ± SD.

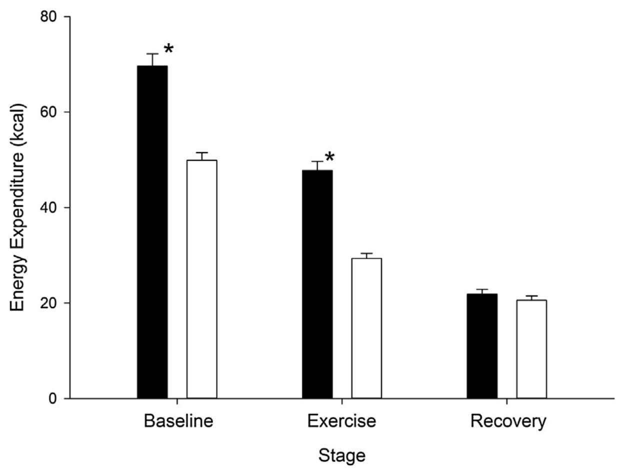

Fig. 2. Differences in energy expenditure between high-speed and standard-speed yoga.

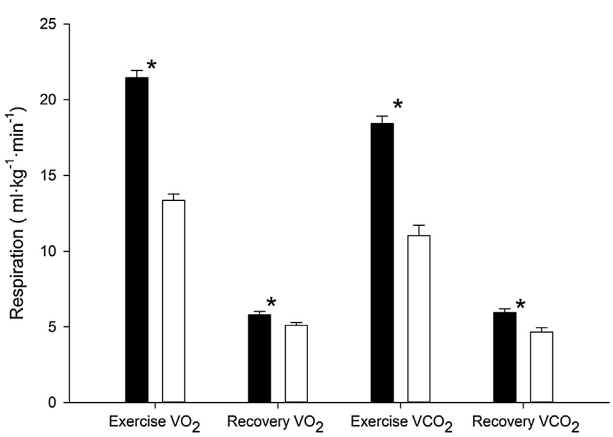

Fig. 3. Differences in oxygen consumption (VO2) and carbon dioxide production (VCO2) between high-speed ■ and standard-speed yoga □. *Significantly greater than the standard speed condition within the same stage (p < 0.05).

3.2. Energy expenditure

After calculating EE_T, there was no significant gender x speed interaction. Significant differences were observed in EE_T between yoga speeds with HSY producing significantly higher EE_T than SSY (MD = 18.55, SE = 1.86, $p < 0.01$). Finally, when we investigated EE during EPOC (EE_{EPOC}), there was no significant gender x speed interaction nor was there a significant difference due to speed (MD = 1.30, SE = 1.22, $p = 0.30$). Fig. 2 displays all EE data.

3.3. Volume of oxygen consumed

During the eight-minute exercise collection period, HSY produced significantly higher VO_2 than SSY (MD = 8.09, SE 0.31, $p< 0.01$) (Fig. 3). There was also a significant gender difference between men and women, but no significant gender x speed interaction.

Finally, there was a significant difference in VO_{2EPOC} between HSY and SSY. When compared to SSY, HSY exhibited a significantly greater VO_{2EPOC} (MD = 0.681, SE = 0.19, $p < 0.01$).

3.4. Volume of carbon dixoide produced

During the eight minute exercise collection period, HSY produced significantly greater VCO_2 than SSY (MD = 7.39, SE = 0.62, $p< 0.01$) (Fig. 3). There was a signifcant gender difference, however, there was no significant gender by speed interaction. HSY produced a significantly greater VCO_{2EPOC} than SSY (MD = 1.30, SE = 0.30, $p < 0.01$).

4. Discussion

To examine the effect of movement speed on EE, we tested two different protcols, HSY and SSY, on both men and women using the Sun-Salutation B sequence. Participants completed eight minutes of continuous sequences, with the total number of completed sequences differing between the two conditions. Rather than dictating the number of sequences to be completed per sequence, we chose to hold the time consistent because this replicates the practices at the majority of yoga studios. As shown in Fig. 2, our results support our hypothesis that there would be a significantly greater increase in EE_T during an eight minute Sun-Salutation B sequence during HSY compared to SSY, with an almost 20 kcal difference between the two speeds.

Excluding EE_{EPOC}, HSY consistently produced a greater energy expenditure than SSY for both men and women. Caloric expenditure during EE_{EPOC} was also higher during HSY but the difference did not reach significance for either gender. Given the significant results seen with EE_T and EE_{Ex}, it is not surprising that VO_2, VO_{2EPOC}, VCO_2, and VCO_{2EPOC} were also significantly greater during HSY compared to SSY.

To our knowledge, our study is the first to quantify EE during a commonly used yoga sequence, while comparing two different yoga speeds. Previous studies investigating the cardiometabolic responses to yoga utilized Hatha yoga methods and concentrated on the meditation portion of yogic practices, typically reporting that subjects enter a hypometabolic state during meditation.[19,26,27] Danucalov et al.,[28] investigated the cardiorespiratory and metabolic changes during the pranayama breathing exercises and meditation portion of a Hatha yoga session in male and female yoga instructors. They found that oxygen uptake increased during the breathing exercises when compared to resting and during meditation. Similarly, carbon dioxide production significantly increased during pranayama, but not during meditation. Additionally, they calculated total EE in kcal for resting state, pranayama, and meditation and found the averages were 38.2 ± 17.7 kcal, 47.0 ± 19.9 kcal, and 24.6 ± 6.9 kcal, respectively. While Danucalov et al. did quantify caloric expenditure during a hatha yoga session, there was no quantification of caloric expenditure of different poses or sequences. Caloric expenditure was also calculated using a pre-set software that did not specify if exercise intensity was taken into account. To calculate kcal, we utilized two different equations prodvided by Jeukendrup and Wallis.[22] Separate equations are provided for low-intensity exercise (40–50% VO_{2max}) and moderate- to high-intensity exercise (50–75% VO_{2max}). Comparing the average VO_2 for each participants' HSY and SSY trial to their VO_{2max} treadmill test, we determined that the SSY and HSY trials were categorized as low-intensity and moderate- to high-intensity exercise, respectively.

Few studies have measured the metabolic cost during an entire yoga session. In a study conducted by Hagins et al.,[20] the metabolic cost of a 56-min Ashtanga yoga session was measured and compared to walking on a treadmill to determine if hatha yoga could meet the recommended level of physical activity for improving and maintaining health and cardiovascular fitness. Rates of oxygen consumption and carbon dioxide production during 28 min of Sun Salutation: 20 min of standing poses and 8 min of lying/meditation poses were measured. They found that the average METs across an entire yoga session was significantly less than the recommended amount of moderate intensity physical activity and paled in comparison to treadmill walking. Similarly, Ray et al.,[18] quantified metabolic cost for different yoga poses and found that the total energy expenditure for a hatha yoga session was 55.45 kcal.

Similar to our study, data during these studies were collected during actual yoga sequences, giving a better approximation of EE during a yoga session. In contrast to our study, only hatha yoga was investigated during these studies, which would be equivalent to our SSY. Hagins et al. reported that the Sun Salutation portion of measurements resulted in 3.73 kcal min^{-1} similar to our SSY yielding 3.30 kcal min^{-1}. However, our HSY protocol yielded a metabolic cost of 5.42 kcal min^{-1} during the Sun Salutation portion, showing that HSY is a more vigorous modality of yoga. Additionally, Ray et al. reported that the Sun Salutations of a Hatha yoga session resulted in an energy expenditure of 41.2 kcal which is similar to our HSY EE_{Ex} results of 43.36 ± 2.67 kcal. However, the hatha yoga Sun Salutations sequence lasted 24 min versus our eight minute sequence, with HSY still resulting in a higher energy expenditure.

4.1. Study limitations

While our study did show that HSY yielded a significantly higher EE than SSY, our collection period was only eight minutes, rather than the standard 45 min to one hour session offered at most yoga studios. Also, our subject pool consisted of young, active yoga practitioners who were 70% women, making our results generalizable to populations with adverse medical conditions more difficult. Our yoga protocol also does not account for warm-up or cool-down poses, which may have altered EE.

5. Conclusion

Despite the limitations on our study, we demonstrated that HSY produces a significantly greater metabolic cost when compared to the more popular and widely utilized SSY. Yoga has repeatedly demonstrated significant musculoskeletal,[29,30] and cardiometabolic benefits[15–17] yet, unlike other exercise modalities like aerobic and resistance training, different variations of yogic practices have not been extensively studied. Our study demonstrated that HSY may be a viable exercise modality to implement in populations where cardiometabolic factors are being targeted. HSY repeatedly exhibited significantly greater metabolic cost when compared to SSY and may assist those who do not meet ACSM requirements of moderate to vigorous physical activity practicing SSY achieve the recommended levels of physical activity. With the proper modifications and considerations to the participants, HSY can be an effective alternative to traditional aerobic and strength training.

Conflict of interest

The authors confirm that there are no known conflicts of interest.

Funding

None.

Acknowledgements

The authors would like to thank all the loyal participants of the Laboratory of Neuromuscular Research & Active Aging and Green Monkey Yoga for their dedicated help.

References

1. Feuerstein G, Payne L, Ebooks Corporation. *Yoga for Dummies. –For Dummies*. 2nd ed. Hoboken, NJ: Wiley Pub.; 2010 [1 online resource].
2. Birdee GS, Legedza AT, Saper RB, Bertisch SM, Eisenberg DM, Phillips RS. Characteristics of yoga users: results of a national survey. *J Gen Intern Med*. 2008;23(10):1653–1658.
3. Clarke TC, Black LI, Stussman BJ, Barnes PM, Nahin RL. Trends in the use of complementary health approaches among adults: United States, 2002–2012. *Natl Health Stat Rep*. 2015;(79):1–16.
4. Sharpe PA, Blanck HM, Williams JE, Ainsworth BE. Conway JM: Use of complementary and alternative medicine for weight control in the United States. *J Altern Complement Med*. 2007;13(2):217–222.
5. Benavides S, Caballero J. Ashtanga yoga for children and adolescents for weight management and psychological well being: an uncontrolled open pilot study. *Complement Ther Clin Pract*. 2009;15(2):110–114.
6. Kristal AR, Littman AJ, Benitez D, White E. Yoga practice is associated with attenuated weight gain in healthy, middle-aged men and women. *Altern Ther Health Med*. 2005;11(4):28–33.
7. Cowen VS, Adams TB. Physical and perceptual benefits of yoga asana practice: results of a pilot study. *J Bodywork Mov Ther*. 2005;9(3):211–219.
8. Kim S, Bemben MG, Bemben DA. Effects of an 8-month yoga intervention on arterial compliance and muscle strength in premenopausal women. *J Sports Sci Med*. 2012;11(2):322–330.
9. Tran MD, Holly RG, Lashbrook J, Amsterdam EA. Effects of hatha yoga practice on the health-related aspects of physical fitness. *Prevent Cardiol*. 2001;4(4):165–170.
10. Gharote ML, Ganguly SK. Effects of a nine-week yogic training programme on some aspects of physical fitness of physically conditioned young males. *Indian J Med Sci*. 1979;33(10):258–263.
11. Cowen VS. Functional fitness improvements after a worksite-based yoga initiative. *J Bodywork Mov Ther*. 2010;14(1):50–54.
12. Ramaswami S, Krishnamacharya T. *The complete book of vinyasa yoga: An authoritative presentation, based on 30 years of direct study under the legendary yoga teacher Krishnamacharya*. New York: Marlowe & Co.; 2005.
13. Ni M, Signorile JF, Mooney K, et al. Comparative impact of power training and high-speed yoga on motor function in older patients with parkinson disease. *Arch Phys Med Rehabil*. 2015.
14. Ni M, Mooney K, Signorile JF. Controlled pilot study of the effects of power yoga in Parkinson's disease. *Complement Ther Med*. 2016;25:126–131.
15. Yang K, Bernardo LM, Sereika SM, Conroy MB, Balk J, Burke LE. Utilization of 3-month yoga program for adults at high risk for type 2 diabetes: a pilot study. *Evid Based Complement Alternat Med*. 2011;2011:257891.
16. Cramer H, Lauche R, Haller H, Steckhan N, Michalsen A, Dobos G. Effects of yoga on cardiovascular disease risk factors: a systematic review and meta-analysis. *Int J Cardiol*. 2014;173(2):170–183.
17. Hagins M, Rundle A, Consedine NS, Khalsa SB. A randomized controlled trial comparing the effects of yoga with an active control on ambulatory blood pressure in individuals with prehypertension and stage 1 hypertension. *J Clin Hypertens (Greenwich)*. 2014;16(1):54–62.
18. Ray US, Pathak A, Tomer OS. Hatha yoga practices: energy expenditure, respiratory changes and intensity of exercise. *Evid Based Complement Alternat Med*. 2011;2011:241294.
19. Clay CC, Lloyd LK, Walker JL, Sharp KR, Pankey RB. The metabolic cost of hatha yoga. *J Strength Cond Res*. 2005;19(3):604–610.
20. Hagins M, Moore W, Rundle A. Does practicing hatha yoga satisfy recommendations for intensity of physical activity which improves and maintains health and cardiovascular fitness? *BMC Complement Altern Med*. 2007;7:40.
21. Pollock ML, Gaesser GA, Butcher JD, et al. ACSM position stand: the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exercise*. 1998;30(6):975–991.
22. Jeukendrup AE, Wallis GA. Measurement of substrate oxidation during exercise by means of gas exchange measurements. *Int J Sports Med*. 2005;26(Suppl. 1):S28–37.
23. P.-O. Åstrand, Experimental studies of physical working capacity in relation to sex and age: E. Munksgaard, 1952.
24. Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exercise*. 1982;14(5):377–381.
25. Medicine ACoS. *ACSM's Guidelines for Exercise Testing and Prescription*. Lippincott Williams & Wilkins; 2013.

26. Sarang PS, Telles S. Oxygen consumption and respiration during and after two yoga relaxation techniques. *Appl Psychophysiol Biofeedback*. 2006;31(2):143–153.
27. Wallace RK, Benson H. The physiology of meditation. *Sci Am*. 1972.
28. Danucalov MA, Simoes RS, Kozasa EH, Leite JR. Cardiorespiratory and metabolic changes during yoga sessions: the effects of respiratory exercises and meditation practices. *Appl Psychophysiol Biofeedback*. 2008;33(2):77–81.
29. Schmid AA, Van Puymbroeck M, Koceja DM. Effect of a 12-week yoga intervention on fear of falling and balance in older adults: a pilot study. *Arch Phys Med Rehabil*. 2010;91(4):576–583.
30. Patel NK, Newstead AH, Ferrer RL. The effects of yoga on physical functioning and health related quality of life in older adults: a systematic review and meta-analysis. *J Altern Complement Med*. 2012;18(10):902–917.