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Difference in muscle activation patterns during high-speed versus standard-speed yoga: A randomized sequence crossover study

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ABSTRACT

Objectives: To compare the difference in muscle activation between high-speed yoga and standard-speed yoga and to compare muscle activation of the transitions between poses and the held phases of a yoga pose.
Design: Randomized sequence crossover trial
Setting: A laboratory of neuromuscular research and active aging Interventions: Eight minutes of continuous Sun Salutation B was performed, at a high speed versus a standard-speed, separately. Electromyography was used to quantify normalized muscle activation patterns of eight upper and lower body muscles (pectoralis major, medial deltoids, lateral head of the triceps, middle fibers of the trapezius, vastus medialis, medial gastrocnemius, thoracic extensor spinae, and external obliques) during the high-speed and standard-speed yoga protocols. Main Outcome Measures: Difference in normalized muscle activation between high-speed yoga and standard-speed yoga.
Results: Normalized muscle activity signals were significantly higher in all eight muscles during the transition phases of poses compared to the held phases ($p < 0.01$). There was no significant interaction between speed × phase; however, greater normalized muscle activity was seen for highspeed yoga across the entire session.
Conclusions: Our results show that transitions from one held phase of a pose to another produces higher normalized muscle activity than the held phases of the poses and that overall activity is greater during highspeed yoga than standard-speed yoga. Therefore, the transition speed and associated number of poses should be considered when targeting specific improvements in performance.

1. Introduction

Yoga has become an increasingly popular and effective exercise modality. It challenges a person's physical, emotional, and spiritual dimensions using different poses (asanas), breathing exercises (pranayama), and meditation techniques.[1] The National Center for Health Statistics show that participation in yoga by adults aged 18y and over linearly increased from 5.1% in 2002 to 6.1% in 2007, and subsequently to 9.5% in 2012.[2]

The most commonly practiced and studied type of yoga is hatha or standard-speed yoga (SSY). Hatha yoga is considered the foundation of all subsequent yoga styles and is regularly used as an alternative source of physical activity. SSY has been shown to improve flexibility,[3] balance and coordination,[4] and muscle strength and power[4] and to attenuate pain.[5] Additionally, yoga has been shown to help with arthritis,[6] weight control,[7] hypertension,[8] diabetes,[9] and cardiovascular disease risk.[10,11]

Power Vinyasa yoga, also known as high-speed yoga (HSY), has emerged as a popular variation of SSY. HSY poses are characterized by shorter held phases and faster transition phases.[12] HSY has been shown to be beneficial in improving balance.[13] and alleviating motor symptoms in patients with Parkinson's disease[14]

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Busko et al.[15] investigated maximal muscle torque and power in the elbow, shoulder, knee, hip, and trunk flexors and extensors in 12 untrained women using power yoga. They found that after a six-month power yoga training program, there were significant increases in maximal muscle torque in the shoulder flexors, and shoulder and elbow extensors. Additionally, they reported that total muscle torque of the arm, leg, and all ten muscle groups significantly improved over the six-month program.

Despite the known benefits of yoga, there are, to our knowledge, no studies that have examined the differences in muscle activation patterns between HSY and SSY. Ni et al.[16] did show that there are variations in muscle activity during specific poses due to practitioners' skill and experience levels. Given that muscle activation patterns are clearly changed with practice, yoga constitutes a neuromuscular training intervention and should therefore follow established training principles. Among the most prominent of these is the principle of exercise specificity. Additionally, EMG activity has been shown to increase in a relatively linear fashion with the rate of force development.[17] and speed of movement[18,19] Therefore, it may be assumed that muscle activity will vary as the movement velocity and pose duration are altered. Identifying differences in muscle activity between HSY and SSY will allow instructors, practitioners, researchers, and healthcare providers to better prescribe yoga practices to target the needs of specific populations.

The purpose of this study was to compare the difference in muscle activation resulting from HSY and SSY. We hypothesized that HSY would produce greater overall activation than SSY. We also hypothesized that HSY would exhibit greater muscle activation during transition phases of the poses, while SSY would exhibit greater muscle activation during the held phases of the poses. Concurrently, we evaluated the difference in energy expenditure and oxygen consumption during HSY versus SSY. Given the unique information offered by each analysis and the volume of data, we will present differences in muscle activation between HSY and SSY in the current article, while the energy expenditure and oxygen consumption results can be found in a separate article.

2. Methods

2.1. Study design

This study used a randomized-sequence crossover trial design that examined the differential impact of high-speed (HSY) and standard-speed yoga (SSY) on the electrical activity of selected muscles. Testing was conducted at the Laboratory of Neuromuscular Research and Active Aging. Subjects were recruited from the University's Wellness Center and local yoga studios. Subjects attended three testing sessions. On day one documents were completed, anthropometric measures taken and maximal oxygen consumption assessed. On days two and three muscle activations patterns were evaluated using EMG during HSY or SSY. The order was randomized, using a random numbers generator (Microsoft Excel), to reduce any carryover effect. To further reduce bias, a designated research assistant performed the randomization of conditions prior to subjects coming to the laboratory; while a separate research assistant scheduled subjects based on their availability. This avoided the influence of knowledge of testing order on subject scheduling. Subjects were informed of their testing condition by the research assistant in charge of randomization upon arriving at the laboratory. All testing sessions lasted approximately one-hour and were completed within a two week period. 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 ± 5.9 years, 6 Men, 33.2 ± 16.3 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. Exclusion criteria included: uncontrolled neuromuscular, orthopedic, or cardiovascular disease or advisement from their physician to abstain from exercise. All procedures were approved by the University's Human Subjects' Subcommittee and participants were informed of the potential risks and benefits associated with the study and provided written consent.

2.3. Conditions and test sessions

2.3.1. Yoga sequences

The Surya Namaskar (sun salutation) B used in this study consisted of 15 poses in the order listed: mountain pose with arms down ($Mnt_{DWN;}$ Tadasana$_{)}$, chair (Chr; Utkaasana), forward fold (FFold; Uttanasana), halfway lift (HLift; Urdhva Mukha Uttanasana), high plank ($Plnk_{HI}$; Dandasana), low plank ($Plnk_{LOW}$; Chaturanga Dandasana), upward facing dog (Dog_{UP}; Urdhva Mukha Svanasana), downward facing dog (Dog_{DWN}; Adho Mukha Svanasana), right side warrior 1 pose (War_{RT}; Virab-hadrasana I), high plank ($Plnk_{HI}$; Uttihita Chaturanga Dandasana); low plank ($Plnk_{LOW}$; Chaturanga Dandasana), upward facing dog (Dog_{UP}; Urdhva Mukha Svanasana), downward facing dog (Dog_{DWN}; Adho Mukha Svanasana), left side warrior 1 pose (War_{LFT}; Virabhadrasana I), mountain pose with arms down ($Mnt_{DWN;}$ Tadasana).

The transition and held phases of each pose of the Sun Salutation B sequence was set to a metronome. The pose times, including the held and transition phases, were 3 s and 12 s for the HSY and the SSY, respectively. Subjects were given the opportunity to familiarize themselves with the sequence set to the pace of the metronome before each testing session. They were then instructed to repeat the sequence with good form continuously throughout the eight-minute testing session.

2.3.2. Day 1

On the first day of testing, subjects completed an informed consent, a standard American College of Sports Medicine health status questionnaire, and a yoga self-assessment questionnaire designed by our laboratory that asked the subject's number of years practicing yoga, current physical activity level, and the average time spent practicing yoga per week. Height and weight were recorded using a standard medical scale (Detecto 439 Beam Scale, Detecto Corp., Webb City, MO). Subjects 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 with a portable breath-by-breath gas analyzer (Oxycon Mobile, Hoechberg, Germany). The testing protocol used was a modified version of the Astrand Treadmill Test.[20] Subjects completed a two-minute warm-up at a grade of 0% and at a self-selected speed. The subject was then directed to select the fastest speed during which he or she could maintain a conversation. This selected speed was kept constant throughout the remainder 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.[21] Heart rate was monitored using a Polar T31 Coded Transmitter (Polar Inc., Lake Success, NY, USA). Test termination was determined using the criteria established criteria from the American College of Sports Medicine.[22] Results of cardiovascular testing are reported elsewhere.