Complementary Therapies in Clinical Practice 31 (2018) 256–261

Contents lists available at ScienceDirect

Complementary Therapies in Clinical Practice

journal homepage: www.elsevier.com/locate/ctcp

Trunk and hip muscle activation during yoga poses: Do sex-differences exist?

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ARTICLE INFO

Article history:
Received 19 January 2018
Received in revised form
13 March 2018
Accepted 14 March 2018

Keywords:
Complementary medicine
Surface electromyography
Gender

ABSTRACT

Objective: To compare core activation during yoga between males and females.
Methods: Surface electromyography was used to quantify rectus abdominis (RA), abdominal obliques (AO), lumbar extensors (LE), and gluteus maximus (GMX) activation during four yoga poses. Data were expressed as 100% of a maximum voluntary isometric contraction. Mixed-model 2×2 analyses of variance with repeated measures were used to determine between-sex differences in muscle activity.
Results: Females generated greater RA activity than males during the High Plank ($P < 0.0001$) and Dominant-Side Warrior 1 ($P = 0.017$). They generated greater AO ($P < 0.0001$) and GMX ($P = 0.004$) activity during the High Plank ($P < 0.0001$). No between-sex EMG activity differences existed for the Chair and Upward Facing Dog.
Conclusion: Findings have provided preliminary evidence for between-sex differences in muscle activation during yoga poses. Clinicians should consider such differences when prescribing yoga to improve muscle strength and endurance.

1. Introduction

Yoga, originating in India over 3000 years ago, offers a holistic approach to health and wellness through physical postures (*asana*), breathing techniques (*pranayama*), and meditation (*dyana*) [1]. The National Institutes of Health has classified yoga as a form of Complementary and Alternative Medicine (CAM) mind-body therapy. The National Center for Complementary and Alternative Medicine defines CAM as a group of diverse medical and healthcare systems and practices not presently considered part of conventional healthcare [2]. As such, yoga exists as both a stand-alone intervention for the exercise enthusiast and more importantly as a complementary therapy for the chronic medically-impacted individual. Yoga is used in combination with conventional western-based medicine and sometimes in place-of-or-alternative-to conventional western-based interventions [3].

Yoga has been shown to benefit individuals with low back pain (LBP) because it incorporates core strengthening and stabilization exercises [4]. Exercises thought to positively address LBP are those that require greater electromyographic (EMG) activity. Researchers have quantified the relative core muscle activity during core strengthening and stabilization exercises [5–10]; however, more limited data exist for core activation during yoga poses [11,12]. Beazley et al. [12] recently reported the relative activation of core muscles during the following poses: High Plank (Plank), Chair, Upward-Facing Dog (Dog), and Dominant-Side Warrior 1 (Warrior). They concluded that many of the poses could improve core strength and endurance. More important, activation levels during many of the poses were similar to those reported during commonly prescribed exercises for the treatment of LBP.

A limitation of many studies has been the use of mixed-sex cohorts of subjects. Findings from more recent studies have shown that males and females exhibit different levels of muscle activity during rehabilitation exercises [13,14], suggesting the need for prescribing sex-specific exercises. To our knowledge, researchers have not investigated potential sex-differences in muscle activity during yoga poses. The purpose of this study was to determine if males and females generate different levels of core muscle activity during yoga poses. Due to the exploratory nature of

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https://doi.org/10.1016/j.ctcp.2018.03.006
1744-3881/

this study, we used the null hypothesis that males and females would generate similar levels of activation.

2. Methods

This study came from a secondary analysis of previously reported cross-sectional data [12]. The primary purpose of this investigation was to quantify the relative amount of EMG activity of core muscles during yoga in untrained individuals. The secondary purpose was to compare the relative amount of core muscle activation during yoga to traditional exercises prescribed for individuals with LBP.

2.1. Subjects

Fifteen males (mean age = 25.4 ± 2.6 y; height 179.5 ± 7.2 cm; and mass 81.2 ± 9.0 kg) and 15 females (mean age = 24.0 ± 1.3 y; height 168.7 ± 6.1 cm; and mass 62.1 ± 8.7 kg) participated. Subjects between the age of 18 and 40 years with less than four weeks of yoga experience were recruited from a local university. All were healthy with no history of spine or upper/lower extremity surgery or any significant spine or lower extremity injury in the past two years. The investigators explained the benefits and risks of this study to all participants, who then signed an informed consent document approved by the Institutional Review Board.

2.2. Procedures

We followed procedures previously described [12]. Briefly, subjects completed gentle stretching exercises for the trunk and lower extremity. Then, each was instructed in the following yoga poses (Figs. 1–4): Chair, Plank, Dog, and Warrior [11]. We used these poses because they were similar to those clinically prescribed for individuals with LBP [15]. During the Chair, subjects stood and flexed the knees 45° (as if to sit in a chair) while keeping their backs straight, upper extremities overhead, and palms facing inward. Subjects assumed a full push-up position for the Plank. For the Dog, subjects were positioned in prone and then pushed upward using the upper extremities to extend the spine. This exercise was chosen because of its similarity to the McKenzie extension exercise. For the Warrior, subjects lunged toward the same side as the dominant hand with the upper extremities outstretched to the side, keeping the trunk and non-dominant-side lower extremity facing forward. Stance width was the length of the lower limb on the dominant hand side. Subjects lunged to the position where the tibia on the dominant hand side was vertical to the floor. This exercise was chosen to facilitate core stabilization during a frontal plane movement.

Fig. 1. The High Plank pose.

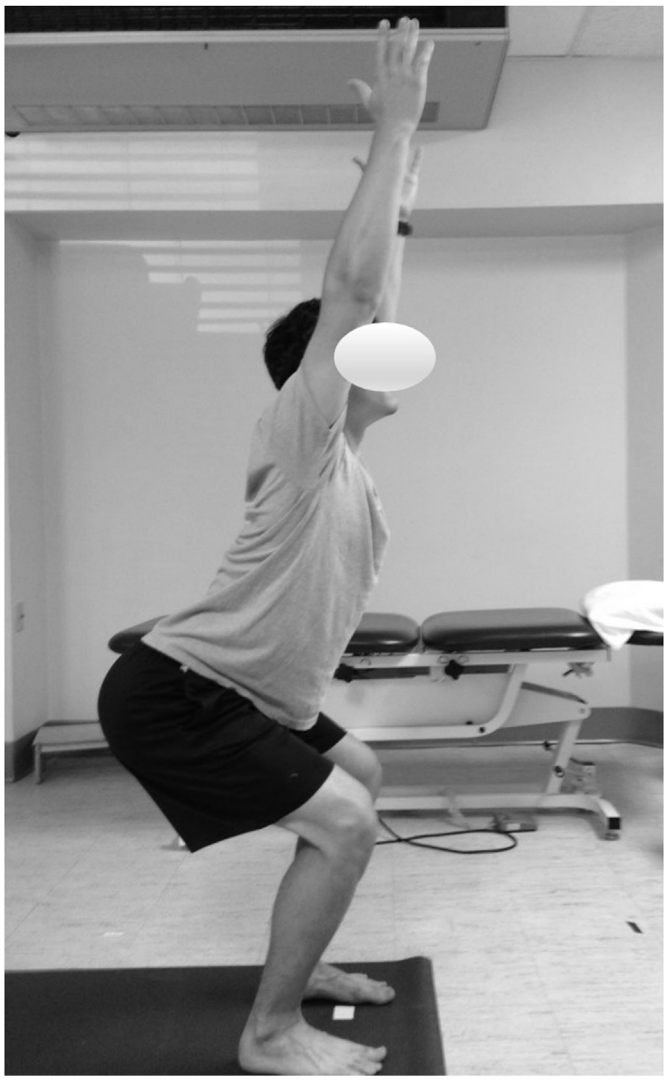

Fig. 2. The Chair pose.

Next, EMG electrodes were placed over the rectus abdominis (RA), abdominal obliques (AO), lumbar extensors (LE), and gluteus maximus (GMX). The skin over these muscle bellies was cleaned (and shaved, if needed) with isopropyl alcohol. Trigno™ wireless sensors (Delsys®, Boston, MA) were placed parallel over each belly [16,17]. Electrode placement was confirmed by observing electrical signals on an oscilloscope as an investigator applied muscle resistance in accordance with common manual muscle testing techniques [18]. To enable normalization of the raw EMG data, subjects