A Survey of Common Delayed Onset Muscle Soreness Patterns within Stand Up Paddle Boarding

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Physical Solutions, UK Nov, 2019

Abstract

Individual sports and activities are associated with muscle-group specific patterns of delayed onset muscle soreness (DOMS) after high intensity participation. The purpose of this survey was to gather data on the common DOMS patterns experienced with Stand Up Paddle Boarding (SUP), and to identify if there are familiar incidence patterns within specific muscle groups. SUP is a relatively new, but fast growing participation water sport. There have been limited research findings on SUP physical demand characteristics, injury incidence, and applied training modalities. There has been a common assumption that SUP is beneficial for core/trunk training. Research via electromyography, Maximum Voluntary Contraction assessment (MVC), and physical output testing, has supported this assumption. Analysis of this survey demonstrated that there were 4 muscle group areas, all located within the trunk/core, that most commonly display DOMS after high intensity paddle boarding, in both women and men. As DOMS is considered to be part of the adaptation and recovery response to high intensity/high load muscle effort, this does support the association that SUP may provide a training and adaptation stimulus for trunk musculature, particularly if performed at higher effort levels and beyond current capacity threshold.

An initial literature search was performed using CINAHL and Medline databases.

Introduction

DOMS is common amongst both recreational and elite athletes. It has a strong association with higher intensity muscle effort, and particularly high loading eccentric activity [1,3]. DOMS is also common following initial uptake and introduction to a specified high intensity physical activity, such as a new sport or technique [3]. Up to six hypothesised theories have been proposed for the mechanism of DOMS, namely: lactic acid, muscle spasm, connective tissue damage, muscle damage, inflammation and the enzyme efflux theories. However, an integration of two or more theories is likely to explain muscle soreness [3,4]. What seems agreed amongst most DOMS studies is that high intensity, or high volume muscular activity is required to provoke it. DOMS is not associated with periods of low intensity exercise. Nie et al (2012) attempted to induce DOMS within their study, and to achieve this they required relatively high intensity exercise stimulus. They used eccentric exercises targeting the neck/shoulder muscles using a specially designed dynamometer. Eccentric shoulder contraction consisted of 5 bouts, each bout lasted 3 min, with 3 min rest period between each bout. The shoulder was elevating against a downward pressure force of 110% maximal voluntary contraction force exerted by the dynamometer.

Muscle units respond to repeated bouts of high intensity and high loading exercise via the process of specific adaptation. DOMS may be part of the physiological response to high intensity training, however Condreuse et al concluded that DOMS should not be considered as an indicator of muscle damage but, rather, a sign of the post exercise regenerative process, which is well known to contribute to the muscular adaptation process [1].

We can assume that for a muscle group to display DOMS then it will have gone through some form of "overload" that takes the group beyond it's current capacity threshold... be that via higher intensity, higher cumulative load, or higher volume, in response to an activity change. As a simplification it is highly likely that the activity change will fall into one of these three categories:
1) A participant taking part in a new activity or exercise, or returning after a break from the activity/exercise. The component muscle groups are pushed beyond capacity, or into unfamiliar capacity loading.
2) A significant change in technique and muscular recruitment patterns that leads to localised overload. This may be seen in an experienced participant who changes a specific technique, or adopts different environmental constraints, such as surface or equipment.
3) An experienced participant who introduces a significant increase in the activities total load. i.e. increasing time, resistance, speed, repetition etc. For example a response to a progressive weight training session, or a jump in a runners distance, or doubling the balls a golfer hits at the range. The muscle groups that contribute most may get pushed beyond current capacity threshold.
The survey within this study was designed to ascertain which muscle groups commonly suffer from DOMS within experienced paddle boarders (essentially category 3). Participants had to have at least one years experience of regular paddle boarding. The average for the survey sample group was 4.88 years of experience, with a sample range between 1 year and 15 years. It was considered that this experienced group will already have developed a substantial foundation of paddling technique, and will have "work hardened" the specific muscle groups associated with paddling.

SUP is considered a "healthy lifestyle" activity choice [7,11]. One aspect of this is its association with being an excellent trunk/abdominal training choice. Research into SUP physiological specifics have not been common place so far, however the trunk/abdominal training assumptions have seen some investigation.

The American Council on Exercise (ACE) commissioned 3 studies into SUP primarily in 2016 [6].
One was core specific. "Core Muscle Activation During Stand Up Paddleboarding", Porcari et al, University of Wisconsin-la Crosse [2016].
The researchers used a novel way of providing a controlled SUP environment by testing paddlers in the steeplechase pit whilst tethered.

Figure 3
Testing Set-up

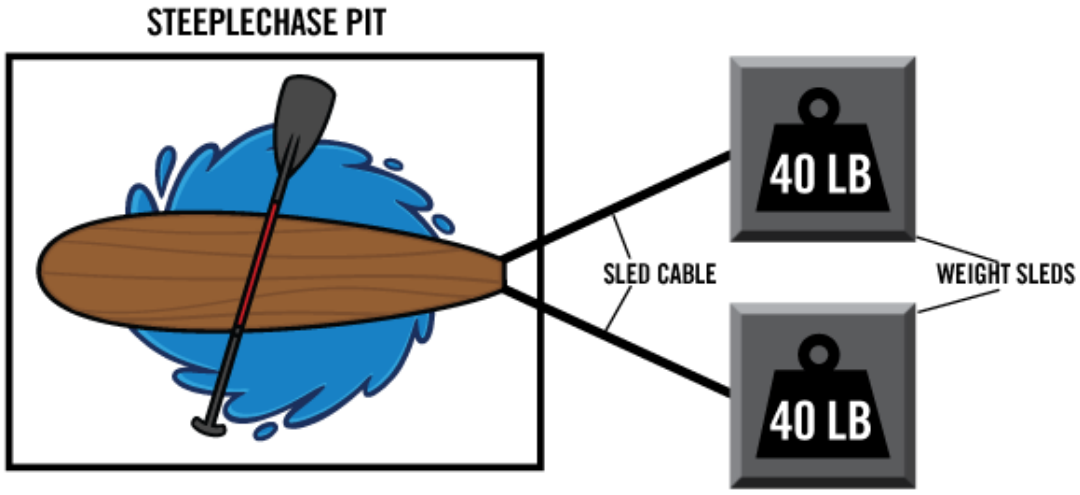


Image: "Core Muscle Activation During Stand Up Paddleboarding", Porcari et al, University of Wisconsin-la Crosse [5]

They used EMG recording to establish % of Maximum Voluntary Contraction (MVC) within core muscle groups. Previous research has concluded that activity that elicits muscle activity above 45% of %MVC should result in measurable strength improvement [12]. On a Rate of Perceived Exertion scale with a max of 20 they were asked to paddle at perceived rates 11, 13, and 15... so basically three levels of ascending effort, with 15 being a high intensity perceived effort.

Figure 4

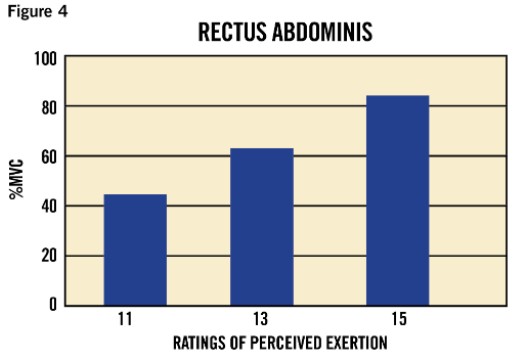


Figure 5

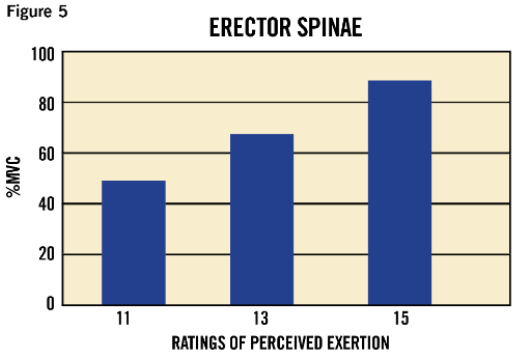


Figure 6

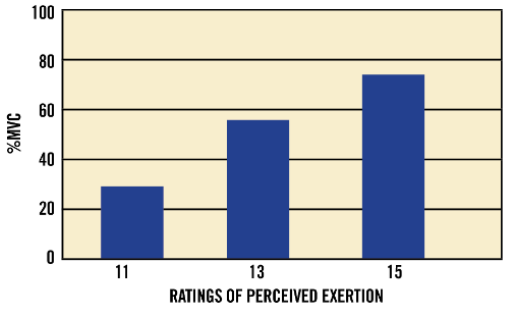


Image: "Core Muscle Activation During Stand Up Paddleboarding", Porcari et al, University of Wisconsin-la Crosse [5]

The results showed that rectus abdominus and erector spinae got above the 45% threshold at all levels of effort, and hit above 80% MVC at level 15 effort. External oblique needed an effort of 15 to get it above the 45% threshold. The authors noted that with the external oblique some degree of technique adaptation occurs at higher effort levels (torso rotation), leading to more recruitment.

Ben Schram et al studied 4 components of fitness in their research "The physiological, musculoskeletal and psychological benefits of paddle boarding",[2016]. One of these was "multi-directional core strength". They took a cohort of 13 through a comprehensive 6 week structured SUP development programme and found that on completion the cohorts trunk strength averaged across their 4 combined test directions improved by 23.9%.

Schram et al [2015] also profiled the sport of SUP . One of their criteria was comparing the abdominal/trunk strength endurance between elite paddle boarders, recreational paddle boarders, and a sedentary group. The elites averaged 253 secs for a prone plank hold, the recreational averaged 165 secs, and the sedentary group 69 secs.

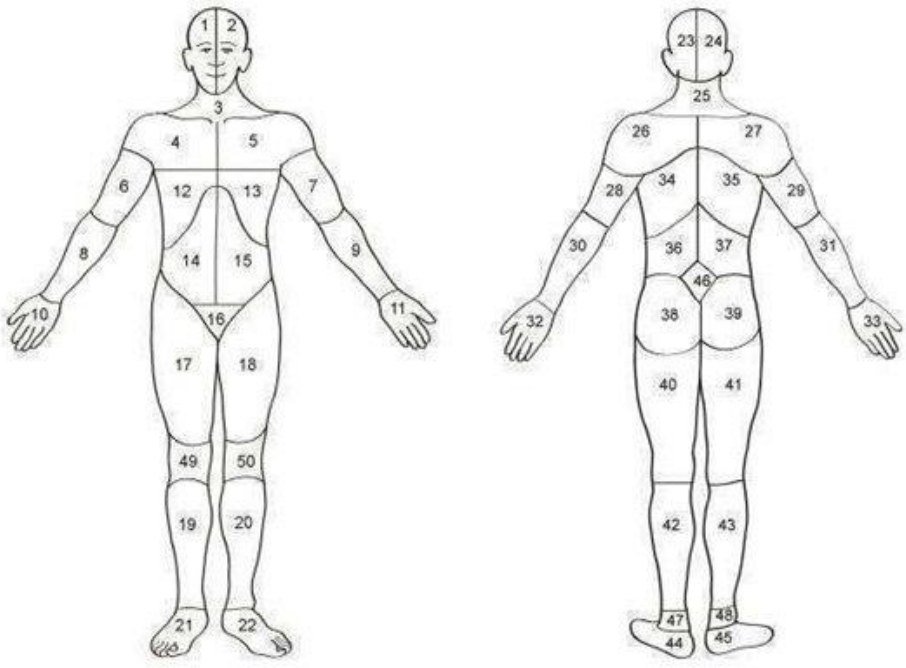
There have been few published electromyography studies of SUP. Reuss et als study [2012]showed high activation levels of abdominal and trunk muscles. They also found high levels of activation of the pectoral and shoulder muscle groups, particularly when using a lab based SUP ergometer.

Methodology

A simple single page survey requesting age, sex, years of SUP participation, and the recording of muscle groups where DOMS is commonly experienced on a numbered body chart.
A brief description of DOMS was included. The participants were asked to consider their DOMS patterns after a "very hard SUP session". It was made clear that we were looking for their opinions after a high intensity effort. We sampled across the disciplines of flat water, downwind, long distance and surf paddling. The survey was distributed on line and via popular SUP groups, organisations and national bodies. It was important to avoid group biases therefore we took a maximum of 3 respondents from identifiable groups on a first reply basis. We also included individual respondents. Replies came from UK, Canada, New Zealand, Australia and the USA.

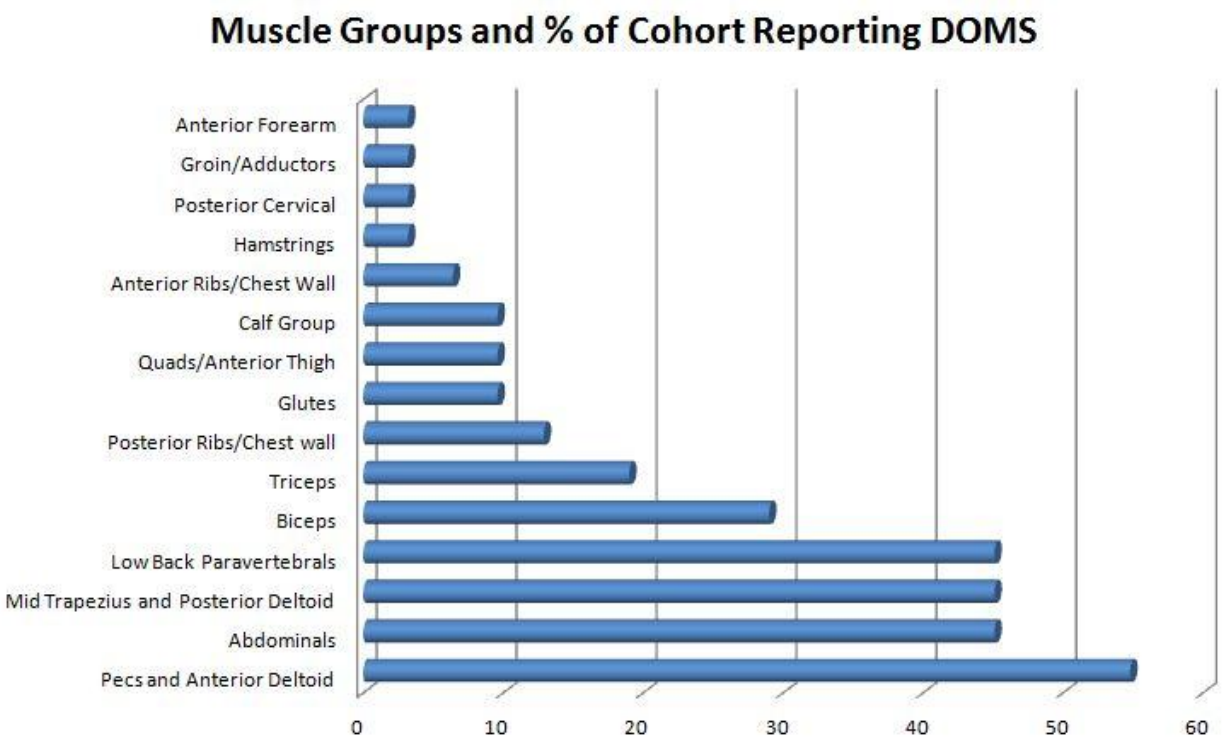
Respondent Profile

- 62 respondents were included within the sample group.
- 28 Women 34 Men
- Average age of complete sample group was 44.8 years old
- Average age of women 41.4 years old
- Average age of men 47.6 years old
- The average years of SUP experience across the group was 4.7 years
- The most inexperienced respondent had 1 years experience, with the most experienced having 15 years experience

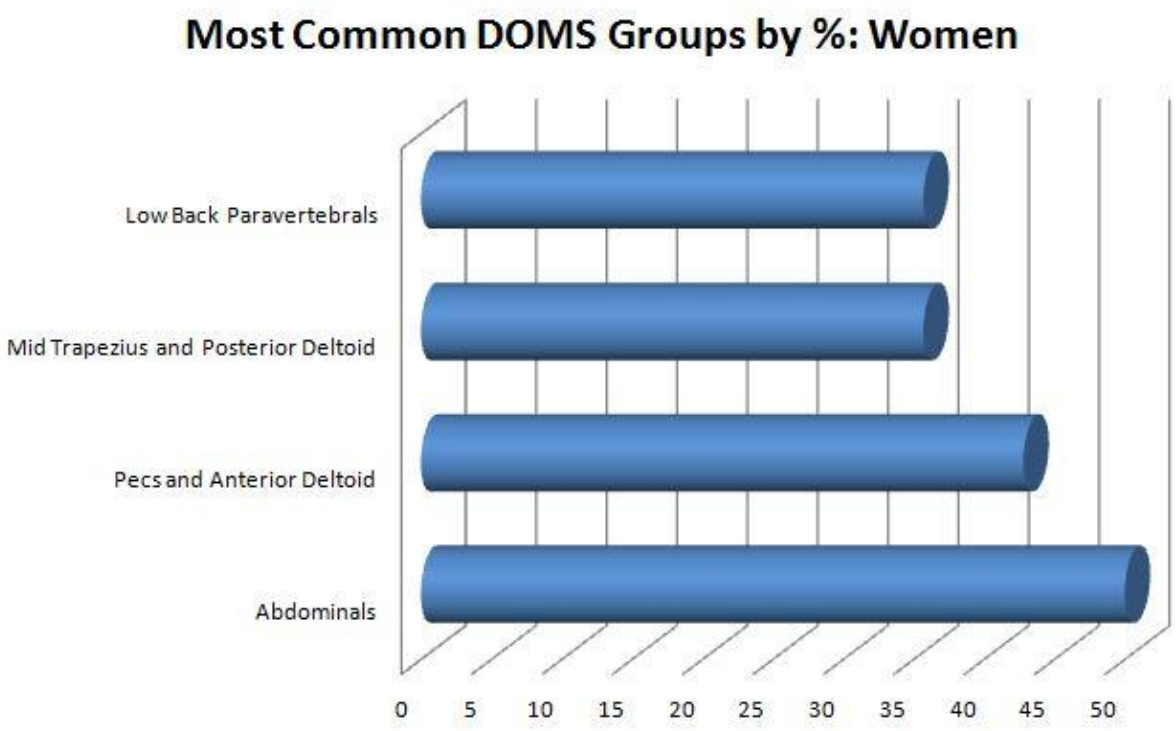


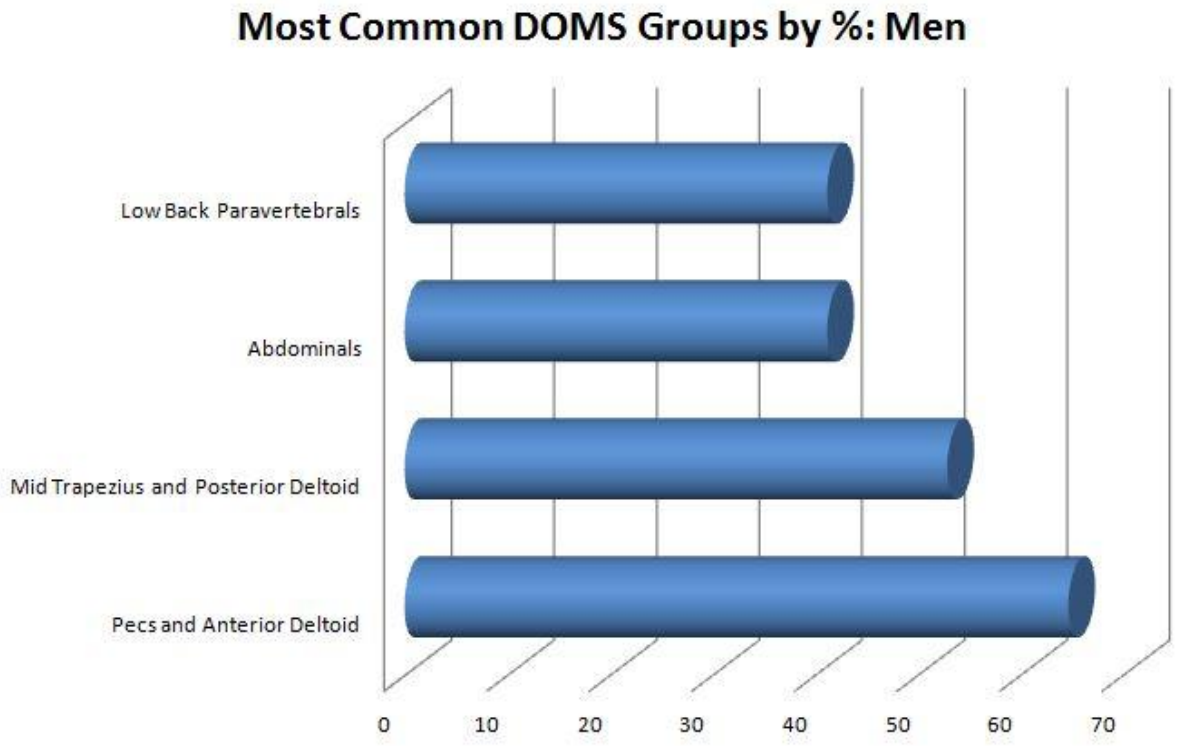
Body chart used in survey

Results



- Over half of the group reported regular DOMS in the pectoral and anterior deltoid area (4 and 5 on body map).
- Three other areas also proved prevalent: the abdominals (areas 14 and 15), mid-trapezius and posterior deltoid (areas 26 and 27), and the low back paravertebrals (areas 36 and 37).
- These 4 muscle group areas were the most prevalent for both male and female respondents but showed a slightly different trend in percentage analysis.





- The most prevalent DOMS area in women was the abdominals at 50% of the survey group.
- The most prevalent DOMS area in men was the pecs and anterior deltoid at 64.7%.
- Despite these differences these four muscle areas showed significantly more DOMS than the other listed muscle area choices in both women and men.

Discussion

Stand Up Paddle Boarding has become a fast growing water sport associated with a healthy lifestyle choice. Specific associations have been made with SUP being beneficial for "core training" and "core stability". There has not been a large amount of research in this area, but what has been performed largely supports these associations. It is generally accepted that DOMS is a response to high load and high intensity muscle effort, and is likely to be part of the process of specific adaptation. The presence of DOMS, and it's level of discomfort, are not a measure of effort or adaptation, but are a strong indication that a bout of high intensity loading has occurred within the affected muscle group.
The survey responses suggest that there is a trend within the muscle groups most affected by DOMS after higher intensity paddle boarding. The four significantly more common muscle group areas are within the "trunk", with a less significant commonality within the biceps and triceps groups. DOMS within the pectorals and anterior deltoid in men could be considered very common at 64.7% of the group. The common DOMS areas correlated with the high level activation areas in Reuss et als 2013 electro-myographic study [9], and the high MVC levels found in Porcari et als core muscle activation study [6]. This does support the association that SUP may provide a training and adaptation stimulus for trunk musculature particularly if performed at higher effort levels.

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