Muscle Activation During Several Battle Rope Exercises

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Battle ropes have become a mainstay in fitness facilities in recent years, typically coiled in the corner of the gym until someone drags them out and gets to work performing any of a variety of movements, often to the wonder of the rest of the gym members.

Battle ropes are versatile, in that they can be used for cardiorespiratory or muscle-strengthening exercise, typically in a high-intensity interval training (HIIT) format. A workout usually consists of alternating bouts of high-intensity exercise followed by either low-intensity exercise or complete rest. Intensity can be altered by changing rope length (they range from 10 to 100 feet), rope thickness (1 to 2 inches in diameter), wave velocity, amplitude, anchor position or the amount of muscle mass used.

Anyone who has ever worked with battle ropes knows they are hard work—but how hard? For this first of two studies on the effectiveness of training with battle ropes (the second study will be published in a future issue of CERTIFIED), ACE asked John P. Porcari, PhD, and his research team in the Department of Exercise and Sport Science at the University of Wisconsin–La Crosse to (1) compare electromyographic (EMG) response in various muscles during five different battle rope exercises to determine which exercises produced the greatest muscle activation and (2) determine if the muscles tested were activated to a sufficient degree to increase muscular strength.

The Study

Because battle ropes are not “lifted,” traditional methods of measuring resistance (e.g., percentage of one-repetition maximum, or %1-RM) are not applicable, so it is difficult to assess how much muscles are being taxed and whether they are being worked sufficiently to elicit strength gains.

Measuring EMG responses solves this dilemma. EMG is used to determine electrical activity within a muscle, which is proportional to the forces being produced by that muscle (Kraemer et al., 2002).

Twelve apparently healthy volunteers between the ages of 20 and 24 years old took part in this study (Table 1). They were required to have previous experience with resistance training, preferably battle rope training.

Table 1
Descriptive Characteristics of Subjects (N=12)

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>22.8 ± 1.27</td>
<td>20–24</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>177.6 ± 6.4</td>
<td>167.6–190.5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>80.8 ± 11.1</td>
<td>59.0–95.3</td>
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</tbody>
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Note: SD = Standard deviation
The eight muscles evaluated in this study were as follows:
- Vastus medialis
- Gluteus maximus
- Erector spinae
- External oblique
- Rectus abdominis
- Upper trapezius
- Anterior deltoid
- Palmaris longus

The subjects then performed the five battle rope exercises described above.

The Results

Muscle activation for each of the eight muscles during each exercise is presented in Figures 1 through 8. The muscle activation data were compared to a threshold of 40% of MVIC, as it is generally accepted that a muscle must be contracting above 40% MVIC in order to gain strength (Fry, 2004).

The findings of this study can be summarized as follows:
- All eight muscles tested were contracting above 40% MVIC during double-arm slams and double-arm waves.
- All of the muscles were contracting above 40% MVIC during double alternating waves, except for the vastus medialis and the rectus abdominis.
- All of the muscles were contracting above 40% MVIC during double outside circles, except for the rectus abdominis and anterior deltoid.
- All of the muscles were contracting above 40% MVIC during single-arm waves, except for the vastus medialis, gluteus maximus and the rectus abdominis.
- The vastus medialis, gluteus maximus, erector spinae and rectus abdominis worked significantly harder during double-arm slams than during any of the other exercises.
- The external oblique worked significantly harder during double-arm slams, double alternating waves and single-arm waves than during double-arm waves and double outside circles.
- The anterior deltoid worked significantly harder during double-arm slams, double-arm waves, double alternating waves and single-arm waves than during double outside circles.
- For the upper trapezius and palmaris longus, there were no significant differences among the exercises.
- It should be noted that for the erector spinae, data were only available for nine subjects due to technical difficulties.

Dr. Porcari nicely summarizes these complex and extensive results: “Battle ropes provide a tremendous total-body workout, but variety of movement is key.”
The Bottom Line

The main purpose of this study was to determine if battle rope exercises can overload the muscles enough to improve muscular strength. With a few exceptions, most of the muscles were contacting at or above the 40% MVIC threshold for the majority of the exercises.

If someone had to choose a single battle rope exercise to include in his or her training, double-arm slams would be the optimal choice, as it was the best exercise for activating the majority of the muscles tested. This is because there is more vertical motion of the entire body, as the subjects brought the battle rope above their heads and then forcefully slammed the rope into the ground. Also, exercise with the battle rope was shown to positively affect grip strength, as reflected by the fact that the palmaris longus was contracting in excess of 75% of MVIC during all exercises.

“Battle ropes provide a tremendous total-body workout, but variety of movement is key.”

![Figure 1](image1.png)

**Figure 1**

Activation of the *vastus medialis* for the five battle rope exercises. Dashed line depicts threshold for increasing muscular strength.

*Statistically significantly greater than all other exercises (p<.05).

![Figure 2](image2.png)

**Figure 2**

Activation of the *gluteus maximus* for the five battle rope exercises. Dashed line depicts threshold for increasing muscular strength.

*Statistically significantly greater than all other exercises (p<.05).
Figure 3
Activation of the **erector spinae** for the five battle rope exercises. Dashed line depicts threshold for increasing muscular strength.

*Statistically significantly greater than all other exercises (p<.05).

Figure 4
Activation of the **external oblique** for the five battle rope exercises. Dashed line depicts threshold for increasing muscular strength.

*Statistically significantly different than Double-arm Waves and Double Outside Circles (p<.05).
**Figure 5**
Activation of the *rectus abdominis* for the five battle rope exercises. Dashed line depicts threshold for increasing muscular strength.

*Statistically significantly greater than all other exercises (p<.05).

**Figure 6**
Activation of the *upper trapezius* for the five battle rope exercises. Dashed line depicts threshold for increasing muscular strength.

Interested in more battle rope exercises? Check out this *Total-body Battle Ropes Workout*, which includes a warm-up and nine exercises.
This research confirms that battle rope exercises may be a great addition to a client’s workout program and offer a full-body training regimen that is fun and challenging. So, encourage your clients to uncoil those ropes and take advantage of this versatile and effective workout tool.

Daniel J. Green is ACE’s Senior Project Manager and Editor for Publications and Content Development. In addition to his work with organizations including the International Association of Fire Fighters and Agriculture Future of America, Daniel writes an ongoing blog series covering lifestyle change for NBCbetter.com. He has also written feature articles for local publications in Western North Carolina (WNC), including WNC Parent and WNC Magazine.

REFERENCES