POST-EXERCISE DECREASE IN HANDGRIP FORCE FOLLOWING A SINGLE TRAINING SESSION IN MALE AND FEMALE CLIMBERS*

Introduction

Rock climbing has gained in popularity and has been recognized as a competitive sport by the International Olympic Committee [1]. The International Federation of Sport Climbing (IFSC) was set up in 2007 as a continuation of the International Council for Competition Climbing which had been in existence since 1997. The IFSC was established in order to regulate competition climbing to meet Olympic Games requirements. Compared to other sports, little research has been done on sport climbing; however biomechanical and physiological approaches have been intensified in recent years [2–4].

Rock climbing demands extreme engagement of the upper extremity muscles, especially finger flexors. Sustained and intermittent isometric forearm muscle contractions provide upward propulsion and balance keeping, especially on overhanging routes [5, 6]. A level of the relative strength of these muscles is a factor limiting climbing performance, since a climber must support and lift his/her body acting against a body weight. Prolonged contractions at maximal and submaximal level cause a significant loss of strength as a result of growing fatigue [1, 7]. During one training session climbers usually make several ascents. It can be assumed that they choose routes due their individual climbing abilities. The aim of the study was to reveal a possible relationship between maximal gripping force and climbing ability as well as to compare a decrease in handgrip force caused by training session in male and female climbers. Basic procedures. Seventy-four climbers (49 males and 25 females) took part in a climbing session on artificial wall. Grip force of both hands was measured twice – before and after the training session. Main findings. The subjects self-reported their climbing abilities in a quantitative Australian scale. In both groups, climbing ability correlated with handgrip force related to body mass. Relative force significantly decreased ($F_{1,72} = 53.2, p < 0.001$) post-exercise from 6.83 ± 1.16 to 5.96 ± 1.18 N/kg in males and from 5.43 ± 0.91 to 4.94 ± 0.84 N/kg in females. The decrease was significantly greater in male climbers ($F_{1,72} = 4.11, p < 0.05$). Conclusions. Less decrease in strength post-climbing in female can positively affect their climbing ability and compensate lower relative handgrip strength. Women should draw more attention to maximal strength training while men to climbing technique and endurance.

Key words: climbing, handgrip, fatigue

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J. Gajewski, B. Jarosiewicz, Decrease in handgrip following a climbing session

Subjects were leaving the training hall. Measurements were done in standing position using hydraulic hand dynamometer. Subjects made two attempts for each hand, and the highest reading was taken for further analysis. Handgrip forces were related to body mass. Spearman’s correlation was used to evaluate relationships between variables. The U-Man-Whitney test and the three-way ANOVA for repeated measures were utilised for the comparison of means. Grouping factor of GENDER (male and female) and repeated factors of HAND (dominant and non-dominant) and MEASUREMENT (before and after training session) were taken into consideration. Significance level was set at \( \alpha = 0.05 \).

Results

The climbing ability (expressed in a quantitative Australian scale) in males did not differ significantly from that in females (20.00 ± 5.07 and 17.84 ± 4.08, respectively). In both groups climbing ability was correlated with relative handgrip force (Spearman’s R = 0.529 and 0.722, for males and females, respectively). Relationship between climbing ability and relative handgrip is presented in Fig. 1.

The ANOVA for repeated measures confirmed obvious significance of main effects: difference between the relative handgrip force measured in dominant and non-dominant hand (effect HAND: \( F_{1,72} = 63.02, p < 0.001 \)) as well as the difference between the handgrip in male and female (effect GENDER: \( F_{1,72} = 23.55, p < 0.001 \)). The mean relative force (averaged for both hands) decreased significantly (effect MEASUREMENT: \( F_{1,72} = 53.2, p < 0.001 \)) post-exercise from 6.83 ± 1.16 N/kg to 5.96 ± 1.18 N/kg in males (13%) and from 5.43 ± 0.91 to 4.57 ± 0.91 N/kg in females (16%).

Table 1. Characteristics of male and female climbers participating in the study

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males (( n = 49 ))</th>
<th>Range</th>
<th>Females (( n = 25 ))</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>27.4 ± 7.6</td>
<td>16–48</td>
<td>25.4 ± 7.2</td>
<td>16–47</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>74.6 ± 8.6</td>
<td>66–93</td>
<td>55.6 ± 6.0</td>
<td>43–65</td>
</tr>
<tr>
<td>Body height (cm)</td>
<td>178.5 ± 6.8</td>
<td>166–198</td>
<td>167.0 ± 5.1</td>
<td>160–180</td>
</tr>
</tbody>
</table>

Figure 1. Relationships between climbing ability (expressed in Australian scale) and relative handgrip force (measured before a training session) in male (\( n = 49 \)) and female (\( n = 25 \)) climbers tested.

Figure 2. Mean (± SD) handgrip forces in male (\( n = 49 \)) and female (\( n = 25 \)) climbers registered for dominant and non-dominant hand before and after the climbing session.
to 4.94 ± 0.84 N/kg in females (8%). Moreover, the decrease in relative force was greater in male than in female climbers (interaction GENDER x MEASUREMENT: F_{1,72} = 4.11, p < 0.05). There were no effects of interaction between HAND and MEASUREMENT (F_{1,72} = 0.074, p n.s.) as well as HAND and GENDER (F_{1,72} = 0.005, p n.s.). Mean (± SD) handgrip forces are presented in Fig. 2.

**Discussion**

It has been shown that climbing ability correlates with relative handgrip strength, which is in line with literature [2, 7]. According to the opinions presented in the literature it can be even stated that climbing ability depends on maximal strength of forearm muscles. However, some authors do not recommend handgrip dynamometry for strength evaluation in climbers [4] since it lacks specificity to climbing. However, handgrip measurements were used in the present study because of their simplicity and accuracy. A significant decrease in handgrip strength following climbing performance was also reported by other authors [1, 8]. Studies on climbing that have measured handgrip maximal voluntary contraction have produced equivocal results. Watts et al. [8] reported even a 22% decrease in handgrip strength after lead climbing. In that study handgrip force continued to be lower than resting values 20 min after the climb. In the present study, the decrements were lower (13% and 9% for males and females, respectively), because the last measurement was not done immediately after the last ascent but while a subject got out of the training hall. The most important findings of this study concern interaction effects. It is obvious that climbing ability positively affects their climbing ability and compensate lower relative handgrip strength. It appears that there should be a different focus in men and women as regards climbing training. Women should draw more attention to maximal strength training while men to climbing technique and endurance.

**References**


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