Physiological Demands of Indoor Wall Climbing in Children

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Introduction

- Regular physical activity and exercise are associated with numerous physical and mental health benefits in men, women and children

  - intrinsically interesting activities
  - encourage lifelong participation
  - maintaining of aerobic fitness
VO$_2$ consumption during various climbing protocols at between 20 - 45 ml·kg$^{-1}$·min$^{-1}$. 

- locomotion pace
- climbing difficulty
- steepness of the wall
- climbing style
- climbing ability
Oxygen Uptake and Energy Expenditure for Children During Rock Climbing Activity

Phillip Baxter Watts and Megan L. Ostrowski
Northern Michigan University

- in children aged 10.9 ± 1.7 years
- continuous traverse and interval traverse
- climbing ~ easy jogging
- peak oxygen consumption **sustained** 31.8 ± 7.2 ml·kg⁻¹·min⁻¹
  - **interval** 27.3 ± 6.2 ml·kg⁻¹·min⁻¹
The aim of the study was to assess the physiological demands of sport climbing in children.
Participants

- 25 children (aged 8–12 years)
- climbing performance IV to V+ RP (UIAA)
- climbing experience ~ 1.5 years

<table>
<thead>
<tr>
<th></th>
<th>Boys (n = 12)</th>
<th>Girls (n = 13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass (kg)</td>
<td>29.7 ± 5.6</td>
<td>33.6 ± 9.4</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>134.3 ± 8.5</td>
<td>138.3 ± 10.8</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>9.5* ± 1.9</td>
<td>17.5* ± 2.9</td>
</tr>
</tbody>
</table>

* significant differences between boys and girls p<0.05
Energy expenditure measurement

- portable gas analyser (MetaMax 3B, Cortex, Germany)
- averaged every 20 seconds
- caloric equivalent of 20.9 kJ (Bertuzzi et al., 2007; Mermier et al., 1997; Rodio, et al., 2008)
Climbing protocol

- 9.8 m high for the vertical (90°) route (N=25)
- 10.0 m for the overhanging (110°) route (N=12)

- difficulty and profile of the routes → preferred routes → discussion

vertical route - IV UIAA, 5.4 YDS, 4a Sport/French
overhanging route - IV+ UIAA, 5.5 YDS, 4b Sport/French

- the time spent by climbing was registered during the 8 following week’s period in all children
Before and after climbing

During climbing
Data analysis

- descriptive statistics (mean and standard deviation)
- t-test for independent samples (boys x girls)
- significance level was set to $P = 0.05$
## Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Vertical route</th>
<th>Overhanging route</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Boys (n=13)</td>
<td>Girls (n=12)</td>
</tr>
<tr>
<td>$\dot{V}O_2$ peak (l·min$^{-1}$)</td>
<td>1.17 ± 0.22</td>
<td>1.24 ± 0.33</td>
</tr>
<tr>
<td>$\dot{V}O_2$ peak (ml·kg$^{-1}$·min$^{-1}$)</td>
<td>39.6 ± 4.4</td>
<td>37.1 ± 4.5</td>
</tr>
<tr>
<td>$V_E$ (l·min$^{-1}$)</td>
<td>33.0 ± 4.8</td>
<td>34.7 ± 8.7</td>
</tr>
<tr>
<td>RER</td>
<td>0.91 ± 0.01</td>
<td>0.91 ± 0.06</td>
</tr>
<tr>
<td>$HR_{peak}$ (beats·min$^{-1}$)</td>
<td>170 ± 15</td>
<td>180 ± 9</td>
</tr>
<tr>
<td>% of $HR_{max}$ (%)</td>
<td>81 ± 7</td>
<td>86 ± 5</td>
</tr>
<tr>
<td>Energy expenditure (kJ·min$^{-1}$)</td>
<td>24.5 ± 4.7</td>
<td>25.9 ± 7.0</td>
</tr>
<tr>
<td>Energy expenditure (kJ·min$^{-1}$·kg$^{-1}$)</td>
<td>0.82 ± 0.16</td>
<td>0.77 ± 0.21</td>
</tr>
<tr>
<td>Energy expenditure (kJ·m$^{-1}$·kg$^{-1}$)</td>
<td>0.15 ± 0.03</td>
<td>0.14 ± 0.04</td>
</tr>
<tr>
<td>Time of climbing (min)</td>
<td>3.6 ± 0.8</td>
<td>3.7 ± 1.1</td>
</tr>
<tr>
<td>Climbed distance (m) boys</td>
<td>293 ± 194</td>
<td></td>
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<td>----------------------------------</td>
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</tr>
<tr>
<td>Climbed distance (m) girls</td>
<td>279 ± 79</td>
<td></td>
</tr>
<tr>
<td>Climbed distance (m) vertical route</td>
<td>275 ± 124</td>
<td></td>
</tr>
<tr>
<td>Climbed distance (m) overhanging route</td>
<td>301 ± 173</td>
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</tr>
</tbody>
</table>

The average time spent by climbing in the training session (60 minutes) during the 8 weeks period was **11.3 ± 4.3 min.**
Discussion

Assessing energy expenditure

- average $\dot{V}O_2$ X peak $\dot{V}O_2$
- anaerobic component was not evaluated
- Steady-state conditions in $\dot{V}O_2$ are necessary for the correct evaluation of energy expenditure
Three phases of $\dot{V}O_2$

1) Cardiodynamic component
2) Primary/Exponential component
3) Slow component
Oxygen Uptake Kinetic Response to Exercise in Children

Samantha G. Fawkner and Neil Armstrong

Fig. 1. The three phases of the kinetic rise in oxygen uptake ($\dot{V}O_2$) in response to a step change in exercise in four different exercise intensity domains.

- $\dot{V}O_2$peak
- MLSS/CP
- LT
Steady state ?
Slow component ?
Oxygen Uptake and Energy Expenditure for Children During Rock Climbing Activity

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Climbing metres

- after eight weeks of indoor wall climbing (Baláš & Bunc, 2007; Baláš, et al., 2009)

- grip strength
- upper body muscular endurance
- amount of relative body cellular mass

80 meters per week in beginner and moderately experienced climbers → maintaining or developing upper body strength.

↓

distance climbed an important factor to assess the effect of climbing

35 metres per climbing lesson → Can we expect any health benefits from the activity?
High-intensity-training (HIT)

- climbing → short intermittent bursts with a high intensity
- one sixth of lesson time actually climbing at moderate or vigorous intensity (calculated from meters climbing per 60-minute lesson).
- to improved health outcomes + significantly improve aerobic fitness in children (Baquet et al., 2010; de Araujo et al., 2012).

Children achieved the \( \dot{V}O_2 \) \text{peak} \text{ around } 40 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1} \rightarrow \text{sufficient intensity to support the health of children through climbing?}
rock climbing fulfils sports medicine recommendations for maintaining a good level of aerobic fitness?

total ascent time should be around 150 minutes per week to match the American College of Sport Medicine (ACSM) → this is the equivalent to approximately 500-700 metres of climbing, per week

0.28 – 0.33 kJ·kg\(^{-1}\)·min\(^{-1}\) X our results are significantly higher, by about 0.46 kJ·kg\(^{-1}\)·min\(^{-1}\)
Conclusion

- sufficient intensity to influence aerobic fitness in children
- High Intensity Interval (HIT) training with longer periods of rest
- it is difficult to estimate an accurate value of energy expenditure for climbing in younger children