Wheeled mobility in sports: Optimal training in handcycling

F.J. Hettinga, P. Schoenmakers, P. Monden, L.H.V. van der Woude

Florentina J. Hettinga
European Research Group of Disability Sports
Paralympic sport: a true challenge
Adapted sports: a challenge for science

- Literature is scarce
- Different handicaps, so no large groups to test with large variation
- Current training guidelines (ACSM) not necessarily true for upper body exercise...
Upper body training: Possibilities of handcycling

- Reference values able-bodied individuals to understand upper body physiology
  - Training responses the same as in lower body?
- Adapt to individual athletes/patients with each their own handicap.
Training studies on handcycling:
55%HRR

Knechtle B, Muller G, Knecht H. Optimal exercise intensities for fat metabolism in handbike cycling and cycling. Spinal Cord 42 (10), 564-572
Able-bodied sports sciences: HIT

HIT vs CT: 7 weeks, 3 times per week High Intensity vs Continuous (M): resistance and velocity

Maximal incremental exercise test
  - Constant velocity (1.11 m/s; 70 rpm)
  - Resistance with a pulley system
    - Start 20 W; 7 W/minute (PO)

Respiratory and metabolic parameters
  - \( VO_2 \), RER, VE, HR (Oxycon Delta)

Gross-efficiency (GE)
RPE and LPD
HIT vs CT

CT = Continuous Training Protocol (n=8)
3 CT training / week 30-min at 55 % HRR

HIT = High Intensity Training Protocol (n=8)
2 HIT training / week at 85 % HRR, 1 CT / week at 55 % HRR

HIT protocol: 4 x 4 - minutes excessive exercise (85 % HRR)²⁴
3 - minutes of passive rest
# High intensity

<table>
<thead>
<tr>
<th></th>
<th>Continuous Training</th>
<th>High Intensity Training</th>
<th>Interaction effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{VO}_2\text{peak (ml·min}^{-1}$</td>
<td>pre $^1$ 2484.7 (436.0)</td>
<td>2624.1 (366.6)</td>
<td>$&lt; 0.01^{**}$</td>
</tr>
<tr>
<td></td>
<td>post 2715.4 (234.5) *</td>
<td>3249.8 (354.1) *</td>
<td>0.141</td>
</tr>
<tr>
<td>$V_e\text{peak (l·min}^{-1}$</td>
<td>pre $^1$ 89.7 (20.3)</td>
<td>99.7 (20.1)</td>
<td>0.141</td>
</tr>
<tr>
<td></td>
<td>post 109.4 (13.4) *</td>
<td>130.4 (13.9) *</td>
<td>0.366</td>
</tr>
<tr>
<td>$HR_{peak \text{ (bpm)}}$</td>
<td>pre $^1$ 179.6 (21.1)</td>
<td>188.4 (9.2)</td>
<td>0.366</td>
</tr>
<tr>
<td></td>
<td>post 185.6 (13.3)</td>
<td>190.3 (7.8)</td>
<td>0.144</td>
</tr>
<tr>
<td>RER</td>
<td>pre $^1$ 1.17 (0.05)</td>
<td>1.18 (0.05)</td>
<td>0.144</td>
</tr>
<tr>
<td></td>
<td>post 1.24 (0.03) *</td>
<td>1.22 (0.06)</td>
<td>0.144</td>
</tr>
<tr>
<td>$PO_{peak \text{ (W)}}$</td>
<td>pre $^1$ 128.9 (26.9)</td>
<td>133.2 (26.2)</td>
<td>$&lt; 0.01^{**}$</td>
</tr>
<tr>
<td></td>
<td>post 169.0 (27.9) *</td>
<td>191.3 (16.2) *</td>
<td>0.141</td>
</tr>
</tbody>
</table>

- Notable increases **CT** and **HIT**. Improvements in $\text{VO}_2\text{peak}$ (+ 23.8 %) and $PO_{peak}$ (+ 43.6%) were larger in **HIT** compared to **CT**.
- No diff. total work HIT (2288 ± 288kJ) and CT (2319 ± 258kJ)
Conclusions

• As in other endurance sports, HIT improved physical capacity and PPO in handcycling

• $\text{VO}_{2\text{peak}}$ and PPO improved more after HIT compared to CT, even though total work spent in the 2 training sessions was equal
## Peak capacity: SCI vs. able-bodied

<table>
<thead>
<tr>
<th></th>
<th>$\text{V}O_2\text{peak}$ (l/min)</th>
<th>$\text{P}O_\text{peak}$ (W)</th>
<th>$\text{H}R_\text{peak}$ (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able-bodied males</td>
<td>2.56 ± 0.32</td>
<td>143.0 ± 18.0</td>
<td>169 ± 12</td>
</tr>
<tr>
<td>Mixed (Paraplegia)</td>
<td>2.14 ± 0.43</td>
<td>111.0 ± 16</td>
<td>172 ± 5</td>
</tr>
<tr>
<td>Tetraplegia</td>
<td>1.21 ± 0.32</td>
<td>38.4 ± 16.7</td>
<td>122 ± 16</td>
</tr>
</tbody>
</table>
Future aims

- Create understanding of upper body physiology
- Get insight into physiology of different handicaps
- Apply knowledge in ADL and sports practice: training guidelines
Thank you

Contact: f.j.hettinga@umcg.nl