Positive Effects of Kayak and Kayak Ergometer Training by people with Paraplegia

Anna Bjerkefors, PT, PhD
Subjective experience

- Sense of freedom
- Easy to get out in the nature
- Good complement to other training
- Social exchange
- Pain relief
- Effects on daily life activities – propelling uphill, easier to transfer into the car
Does kayaking also result in measurable effects?
How to measure?
Video: Hans Rosdahl och Johnny Nilsson
Why is trunk control important?

*Impaired trunk control is related to*

shoulder pain  
(Sinnot et al. 2000)

decreased propulsion efficiency  
(Dallmeijer et al. 1998, Schantz et al. 1999)

respiratory dysfunction  
(Baydur et al. 2001)

development of pressure sore  
(Karataş et al. 2008)
Intervention Study 1 - Open-sea kayaking

12 individuals with SCI
8-week-period
2 – 3 times/week
Sub- and maximal oxygen consumption

Bjerkefors, Rosdahl et al. 2005
Fig. 1. The experimental set-up for balance testing. The subject is sitting in a special chair which is also used in the kayak. The chair is firmly attached to a force plate. The subject’s feet are resting on a support connected to the chair via steel rods.

Grigorenko et al., 2004
Table IV. Subjective experiences of direct effects of the kayak training as stated in a questionnaire presented to the individuals with spinal cord injury 1 year after the training period

<table>
<thead>
<tr>
<th></th>
<th>General well being</th>
<th>Sitting balance in wheelchair</th>
<th>Shoulder strength</th>
<th>Upper body stability</th>
<th>Spasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>No improvements</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Small improvements</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Moderate improvements</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Large improvements</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Don’t know</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
Aerobic capacity

Quality of life

Subjective experiences; e.g. sitting balance & shoulder strength
Intervention Study 2 – Kayak ergometer

weather-independent adjustable balance module
Subjects

- 10 persons with SCI (7 M, 3 F)
- T3 – T12
- 23 – 60 year
- year post injury: 2 - 26
Training

3 times/week (total: 30)  10-week-period  60 min  the intensity and the balance  demand successively increased
## Balance demand, intensity and distance

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Balance demand</th>
<th>Intensity (W)</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>first  last</td>
<td>first  last</td>
<td>first  last</td>
</tr>
<tr>
<td>1</td>
<td>6   8</td>
<td>19   40</td>
<td>2678 4387</td>
</tr>
<tr>
<td>2</td>
<td>7   9</td>
<td>15   32</td>
<td>2736 4400</td>
</tr>
<tr>
<td>3</td>
<td>5   8</td>
<td>15   39</td>
<td>2389 4335</td>
</tr>
<tr>
<td>4</td>
<td>5   8</td>
<td>20   44</td>
<td>2807 3919</td>
</tr>
<tr>
<td>5</td>
<td>8   9</td>
<td>36   75</td>
<td>3289 4540</td>
</tr>
<tr>
<td>6</td>
<td>6   9</td>
<td>22   34</td>
<td>3200 4408</td>
</tr>
<tr>
<td>7</td>
<td>5   9</td>
<td>15   34</td>
<td>2626 4393</td>
</tr>
<tr>
<td>8</td>
<td>7   9</td>
<td>33   58</td>
<td>3046 6237</td>
</tr>
<tr>
<td>9</td>
<td>7   9</td>
<td>15   31</td>
<td>2385 4099</td>
</tr>
<tr>
<td>10</td>
<td>7   9</td>
<td>14   27</td>
<td>2870 3500</td>
</tr>
<tr>
<td>mean</td>
<td>6   9</td>
<td>20   41</td>
<td>2803 4422</td>
</tr>
<tr>
<td>SD</td>
<td>1   1</td>
<td>8    15</td>
<td>308  709</td>
</tr>
</tbody>
</table>
Shoulder muscle strength

- Improved
- Flexion – extension
- Abduction – adduction
- Internal – external rotation
Sit-and-reach-tests

forward, bilateral

forward, unilateral

45° rotated, unilateral
Sit-and-reach test

- Forward (both hands)
- Forward (right hand)
- Forward (left hand)
- Rotated (right hand)
- Rotated (left hand)

Differences (%)

[Graph showing differences for various reach test conditions]
Transfer and wheelchair tests

Transfer to a plank bed* (height, cm)

5 m on the rear wheels (time, s)

Mounting a platform* (height, cm)

* Significantly improved
Transfer and wheelchair tests

5 laps in a figure-8 (time, s)
Propelling 15 m on a level surface (time, s)*
Propelling 50 m up a 3° incline (time, s)*

* Significantly improved
Kinematic responses to unexpected perturbations

Medio-lateral direction

Anterio-posterior direction
Unexpected perturbations in lateral direction
Subjective experiences

<table>
<thead>
<tr>
<th>General well-being</th>
<th>Cardio-vascular fitness</th>
<th>Upper body stability</th>
<th>Shoulder strength</th>
<th>Reach an object</th>
<th>Propel uphill</th>
<th>Transfer into a car</th>
<th>Propel over a curb</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Unchanged”</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>“Small improvement”</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>“Moderate improvement”</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>“Large improvement”</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>“Very large improvement”</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>“Don’t know”</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Conclusion

kayak ergometer training improved
• shoulder muscle strength
• functional performance
• postural stability

suitable activity in post-rehabilitation and recreation

did not cause any shoulder pain
Thank you for your attention!

anna.bjerkefors@gih.se