Consideration of Passive Drag in IPC Swimming Classification System

Influence of Specific Impairments on Passive Drag

Yim-Taek Oh\textsuperscript{1}, Conor Osborough\textsuperscript{1}, Brendan Burkett\textsuperscript{2}, Carl Payton\textsuperscript{1}

\textsuperscript{1}Manchester Metropolitan University, UK
\textsuperscript{2}University of the Sunshine Coast, Australia
Introduction

- Swimmer’s speed ≈ Propulsion + Drag

- A fair classification system should evaluate an individual’s potential to achieve both of these things.

- In Human Swimming:

  - In able-bodied swimming
    Passive drag – highly dependent on anthropometry
    Active drag – more dependent on technique

    (Toussaint, 1990; Kolmogorov & Duplishcheva, 1992)
• Passive drag vs IPC Class

• Passive drag vs Anthropometry
  - Para-swimmers with similar body dimensions can experience quite different passive drag. May be due to differences in the nature of their impairment.
Aims

1) Determine whether para-swimmers’ passive drag changes in accordance with their impairment type.

2) Identify whether para-swimmers with certain impairments have an advantage or disadvantage, with respect to passive drag, under the current classification system.

Hypotheses

1) A para-swimmer’s passive drag will be influenced by their impairment type.

2) Certain impairments can advantage or disadvantage a para-swimmer, with respect to drag, under the current classification system.
Methods

Data Collection

• 153 para-swimmers (93♂, 60♀). 97% competed in London Paralympics or World champs at Montreal or Glasgow.

• Classes 1 – 10.

• 25±8 yrs, 1.60±0.25 m, 60.7±12 kg

• Towed on surface at 1.5 m·s⁻¹ in their most streamlined position.

• Drag measured using an in-line load cell in a neutrally buoyant ‘torpedo’.

• Force data sampled at 100 Hz.

• 3 – 7 trials conducted per swimmer.

• Swimmer’s lowest drag force was normalised for body mass.
Methods

Impairment Groups

1) Spinal Cord Injury or Polio (SP1-8)
2) Cerebral Palsy (CP1-8)
3) Short Stature (SS1-2)
4) Les Autres (LA1-10)
5) Amputee or Dysmelia
   - Double-leg Amputee (DLA1-8)
   - Single-leg Amputee (SLA1-5)
   - Arm Amputee (AA1-5)
Methods

Passive Drag Band (PDB 1-10)
- Swimmers were assigned to one of ten passive drag bands according to their normalised passive drag.
- Those with highest normalised passive drag were in PDB1.
- IPC Class integer compared to PDB integer.

Code for IPC Class vs PDB Differences
- Navy : IPC Class ➔ PDB by 3 or more. Swimmers who have smaller drag than others in the same IPC Class
- Blue : IPC Class ➔ PDB by 2. 
- Green : IPC Class ➔ PDB by 1.
- Yellow : IPC Class ➔ PDB. 
- Orange : IPC Class ➔ PDB by 1.
- Scarlet : IPC Class ➔ PDB by 2. 
- Red : IPC Class ➔ PDB by 3 or more. Swimmers who have greater drag than others in the same IPC Class
Results: Impairment sub-groups vs Passive drag

Impairment sub-groups
- Spinal Cord Injury or Polio (SP)
- Cerebral Palsy (CP)
- Les Autres (LA)
- Short Stature (SS)
- Double-leg Amputee (DLA)
- Single-leg Amputee (SLA)
- Arm-Amputee (AA)

Normalised Drag (N-kg⁻¹)

Impairment sub-groups
Results: Passive Drag Band (PDB)

<table>
<thead>
<tr>
<th>IPC Class</th>
<th>PDB&lt;IPC</th>
<th>IPC=PDB</th>
<th>PDB&gt;IPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>+1</td>
</tr>
<tr>
<td>11</td>
<td>17</td>
<td>31</td>
<td>42</td>
</tr>
<tr>
<td>(7.2%)</td>
<td>(11.1%)</td>
<td>(20.3%)</td>
<td>(27.5%)</td>
</tr>
<tr>
<td>+2</td>
<td>+3</td>
<td>+4</td>
<td>+5</td>
</tr>
<tr>
<td>26</td>
<td>16</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>(17.0%)</td>
<td>(10.5%)</td>
<td>(6.5%)</td>
<td></td>
</tr>
</tbody>
</table>
Results / Discussions

Physical Impairment type of para-swimmers (n=153) in each PDB
Discussions
Conclusions

1) A para-swimmer’s passive drag is influenced by their impairment type.

2) Para-swimmers with Short Stature and para-swimmers with SCI with limited range of movement generally had higher drag than the other swimmers in the same class.

3) Para-swimmers with: i) 4 limbs amputated below knee/elbow and ii) severe SCI or CP but with no restriction at the shoulder, had relatively low drag compared to others in the same class.

4) Passive Drag Band may be a useful tool to help visualize which impairment types may advantage or disadvantage swimmer in terms of passive drag.
Thank you for your attention

Acknowledgements

British Para-Swimming....


Results: IPC Class vs PDB differences