Wheelchair Mobility Performance enhancement by changing wheelchair properties; what is the effect of grip, seat height and mass?

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Introduction

Wheelchair configuration and performance
Performance in wheelchair sports

- Athlete – wheelchair
  - One functional unit
- Individual athletes
  - Class / athlete bound performance goals
  - Sport / field position bound performance goals
- Wheelchair mobility performance
  - Optimize wheelchair settings / configuration

Wheelchair Mobility Performance

Model by Kees van Breukelen
Methods

Wheelchair Mobility Performance Monitor
Wheelchair basketball field test
Normal wheelchair setup and five altered settings
Wheelchair Mobility Performance Monitor

- Key wheelchair kinematics measured with IMUs

Wheelchair basketball field test

- Straight sprint – interval
- Curves - interval
- Turn on the spot – interval
- Without / with ball
- Combined

Test conditions: changes in wheelchair setup

**Seat height**
- Low (L) -7.5%
- High (H) + 7.5%

**Added mass**
- Mass Central (MC) + 7.5%
- Mass Distributed (MD) + 3.75% & + 3.75%

Neutral (N)  Grip (G)
Outcomes

• Number of outcomes
  • **Six** WMPM outcomes complete test **per test condition**
  • **Four** outcomes **per test part** (n=14) and **per test condition**
  • **Seven** comparisons

• Effect size (ES)
  • Differences expressed in ES
    • Small $|0.2| < |0.5|$
    • Moderate $|0.5| < |0.8|$
    • Large $>|0.8|$
  • Number of ES $>|0.2|$
Results & conclusions

Wheelchair Mobility Performance
Outcome level effect sizes
Conclusions
Wheelchair settings

### Linear
1. Avg. speed (m/s)
2. Avg. best speeds (m/s)
3. Avg. acceleration (m/s²)

### Rotational
4. Avg. rotational speed in curve (°/s)
5. Avg. best rot. speed in turn (°/s)
6. Avg. rot. acceleration (°/s²)

<table>
<thead>
<tr>
<th>Weight Distr.</th>
<th>Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td></td>
</tr>
</tbody>
</table>

- Neutral
- Low
- High
- Weight Central
- Weight Distr.
### Outcome level

- **Outcomes**
  - 4 main outcomes
  - 14 test parts
  - 6 WMP outcomes
  - 7 comparisons
  - 434 outcomes

- **Effect size**
  - Small |0.2| < |0.5|
  - Moderate |0.5| < |0.8|
  - Large > |0.8|

<table>
<thead>
<tr>
<th>WMP</th>
<th>Overall</th>
<th>Variable</th>
<th>12m straight</th>
<th>12m curve</th>
<th>Turn on the spot</th>
<th>Comb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral - Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sp Average</td>
<td>-0.09</td>
<td>Abs max</td>
<td>0.21</td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.10</td>
</tr>
<tr>
<td>Best 2</td>
<td></td>
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</tbody>
</table>

### Comparisons (n=7)

- 434 outcomes!
Seat height

- Minimal effect on speed
- Hardly effect on acceleration
- Most effect on rotational speed
- Minimal effect rotational acceleration
Added mass

- Minimal effect on speed
- Clear effect on acceleration
  - No difference between location
- Clear effect on rotational speed in distributed mass
- Very clear effect on rotational acceleration in distributed mass
Conclusions settings

- Seat height
  - High, (rotational) performance ↓
- Mass central
  - Acceleration ↓
- Mass distributed
  - Acceleration ↓
  - Rotational speed & acceleration ↓
- Grip
  - Hardly effect

Percentage of Effect Sizes > 0.2

- Rotational Acc
- Rotational Speed
- Forward Acc
- Forward Speed

座高
- 高，（旋转）性能下降
- 质量中央
  - 加速度下降
- 质量分布
  - 加速度下降
  - 旋转速度及加速度下降
- 抓握
  - 几乎没有影响
Perspective

• WMPM method & fieldtest
  • Sensitive to small changes in wheelchair configuration

• Structural WMPM monitoring
  • Evaluate training effect
  • Optimize wheelchair configuration
Out of the lab, onto the court

Wheelchair Mobility
Performance quantified

Free copies available!