Wheelchair mobility performance of elite wheelchair tennis players during four field tests: Inter-trial reliability and construct validity

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Wheelchair tennis

› Increasing popularity
› Wheelchair mobility performance
› Tennis racket

¹ Gold, J. R., & Gold, M. M., 2007
² De Witte et al., 2018
Previous Research

› Wheelchair basketball$_{2,3}$ & rugby$_{4}$
› Research scarce
› IMUs$_{5,6}$ $\rightarrow$ More detailed performance
› Four field tests developed

$^2$De Witte et al., 2018
$^3$De Groot et al., 2012
$^4$Gee et al., 2018
$^5$Van der Slikke et al., 2015
$^6$Van der Slikke et al., 2016
Aims

1. Inter-trial reliability and construct validity of four field tests
2. Assess added value of each test
Participants and design

› 21 participants (12 juniors, 9 adults)
› 4 skill oriented tests (2 trials each)
› 3 IMUs
› Own wheelchair and racket
Placement IMUs
Data Analysis

› Trial times based on IMU data
  • 20m Sprint, 20m point
  • Other tests, based on figures

› Wheelchair mobility performance variables
<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Velocity</strong></td>
<td><strong>$V_{\text{mean}}$</strong> Mean velocity on whole test [$\text{m.s}^{-1}$]</td>
</tr>
<tr>
<td></td>
<td><strong>$V_{\text{peak} 5/10/20\text{m}}$</strong> Peak velocity first 2/5/10 meters</td>
</tr>
<tr>
<td></td>
<td>[m.s$^{-1}$]</td>
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<tr>
<td></td>
<td><strong>Pos$V_{\text{peak}}$</strong> Position of the peak velocity [m]</td>
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<tr>
<td></td>
<td><strong>$V_{\text{peak}}$</strong> Peak velocity on whole test [m.s$^{-1}$]</td>
</tr>
<tr>
<td><strong>Acceleration</strong></td>
<td><strong>$a_{\text{peak} 5/10/20 \text{m}}$</strong> Peak forward acceleration first 2/5/10 meters [m.s$^{-2}$]</td>
</tr>
<tr>
<td></td>
<td><strong>Pos$a_{\text{peak}}$</strong> Position of peak forward acceleration [m]</td>
</tr>
<tr>
<td></td>
<td><strong>$a_{\text{peak}}$</strong> Peak forward acceleration on whole test [m.s$^{-2}$]</td>
</tr>
<tr>
<td><strong>Push characteristics</strong></td>
<td><strong>$N_p$</strong> Number of pushes</td>
</tr>
<tr>
<td></td>
<td><strong>$D_{p1,2,3}$</strong>: Displacement after first, second, third push [m]</td>
</tr>
<tr>
<td></td>
<td><strong>$CT_{\text{mean}}$</strong>: Mean Cycle Time [s]</td>
</tr>
<tr>
<td><strong>Rotational velocity/acceleration</strong></td>
<td><strong>$\text{Rot}V_{\text{mean right/left}}$</strong> Mean rotational velocity during right/left turn</td>
</tr>
<tr>
<td></td>
<td><strong>$\text{Rot}V_{\text{peak right/left}}$</strong>: Peak rotational velocity during right/left turn</td>
</tr>
<tr>
<td></td>
<td><strong>Rota$\text{peak}$</strong>: Peak rotational acceleration</td>
</tr>
</tbody>
</table>
Statistical Analysis

› Inter-trial reliability
  • Absolute reliability (Paired t-tests)
  • Relative reliability (ICC)

› Construct validity
  • Three Repeated measures ANOVA
  • MANOVA
Statistical Analysis (2)

› Association among end times
   • Pearson correlations
Results Reliability

![Graph showing results reliability with 95% LOA (M ± 1.96 SD)]
Results validity and association

› Adults were faster on all 3 tests
› Wheelchair mobility performance
  • Velocity
  • Acceleration
  • Rotations
  • Not the Position
› Strong association
Discussion

› Inter-trial reliability ✓
  • Illinois at least two times

› Construct validity ✓
  • Discrimination can be made

› Association among tests
  • 20m Sprint and Spider test
Future Recommendation

› Coast down test
› Power Output
› Interaction with the ball
› Key factors during match
Conclusion

› Field tests are reliable and valid to measure wheelchair mobility performance
› With the use of IMUs it is possible to visualize and give important information
Thank you for your attention