Introduction

The human effort required to maneuver a manual wheelchair is directly linked to the inertia and resistive losses of the system. In this study, we investigate the impact of three different commercial drive wheels on the propulsion torque of a straight maneuver and fixed wheel turning.

Methods

The Anatomical Model Propulsion System (AMPS), was implemented to improve the repeatability of maneuvers and enable accurate measurement of task propulsion torque. We define task propulsion torque as:

\[ \tau = \tau_{rW}(F_{tan})_{rW} + \tau_{pW}(F_{tan})_{pW} \]

where \( r \) is the wheel radius and \( F_{tan} \) is the tangential push force.

Results

<table>
<thead>
<tr>
<th>Torque (Nm)</th>
<th>Spoke</th>
<th>Spinning</th>
<th>Mag Solid</th>
<th>Spoke (tile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.29</td>
<td>-8.5%</td>
<td>+11.4%</td>
<td>-3.5%</td>
<td>+11.9%</td>
</tr>
<tr>
<td>0.4</td>
<td>-6.8%</td>
<td>+9.8%</td>
<td>-8.5%</td>
<td>+4.0%</td>
</tr>
<tr>
<td>0.69</td>
<td>-5.2%</td>
<td>+2.8%</td>
<td>-7.1%</td>
<td>-0.3%</td>
</tr>
</tbody>
</table>

The acceleration torque and steady-state torque were determined by averaging the measured propulsion torque (sampled at 200 Hz) over the acceleration phase and steady-state phase of the maneuvers, respectively. Propulsion torque values for turning were obtained by averaging results for left and right turns.

Discussion

- The difference in propulsion torque between wheels does not change significantly with acceleration.
- In straight motion, the Spinning wheel reduces propulsion effort due to reduced system mass and rotational inertia; the solid mag’s elevated propulsion torque can be attributed to increased rolling resistance.
- In turning, the Spinning wheel’s reduction of propulsion torque can be attributed to reduced resistive losses and rotational inertia; the solid mag’s elevated propulsion torque can be attributed to increased resistive losses.
- Carpet propulsion torque is greater for all conditions due to a large increase in rolling resistance and scrub loss.

Conclusion

- The Spinning wheel reduces propulsion effort due to its reduced mass, rotational inertia, and resistive losses.
- The solid mag wheel elevates propulsion effort due to its increased resistive losses.
- Changes in resistive loss due to different surface conditions may diminish the impact of inertial differences between drive wheels.

References


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Impact of Drive Wheels on Manual Wheelchair Propulsion Torque

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