Effect of seat height on manual wheelchair foot propulsion while wheeling forward on a smooth level surface: a repeated-measures crossover study

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Abstract

Purpose: To test the hypotheses that, during manual-wheelchair foot propulsion forward on smooth level surfaces, lowering the seat height increases speed, push frequency and push effectiveness, and decreases perceived difficulty.

Materials and methods: In a repeated-measures crossover study, 50 able-bodied participants used one foot to propel a manual wheelchair 10 m on a smooth level surface at 5 seat heights in random order, ranging from 5.08 cm below to about 5.08 cm above lower-leg length in random order. We recorded Wheelchair Skills Test (WST) capacity scores and used the Wheelchair Propulsion Test (WPT) to calculate speed (m/s), push frequency (cycles/s) and push effectiveness (m/cycle). We also recorded the participants’ perceived difficulty (0-4) and video-recorded each trial.

Results: WST capacity scores were reduced at the higher seat heights. Using repeated-measures models (adjusted for age, sex and order), there were negative relationships between seat height and speed (p < 0.0001) and push effectiveness (p < 0.0001). Lowering the seat height by 5.08 cm below lower-leg length corresponded to improvements in speed of 0.20 m/s and in push effectiveness of 0.20 m/cycle. The trend for push frequency was also significant (p = 0.003) but the effect size was smaller. Perceived difficulty increased with seat height (p < 0.001). The video-recordings provided qualitative kinematic data regarding the seated “gait cycles”.

Conclusions: During manual-wheelchair foot propulsion forward on smooth level surfaces, lowering the seat height increases speed and push effectiveness, and decreases perceived difficulty.

Methods

- Repeated-measures crossover study.
- 50 able-bodied participants.
- Manual wheelchair.
- One-foot propulsion 10 m forward on a smooth level surface.
- 5 seat heights, in random order, ranging from 5.08 cm below to about 5.08 cm above lower-leg length ("neutral").
- Wheelchair Skills Test (WST) capacity scores.
- Wheelchair Propulsion Test (WPT): speed (m/s), push frequency (cycles/s), push effectiveness (m/cycle).
- Perceived difficulty (0-4).
- Video-recordings.
- Repeated-measures models (adjusted for age and sex).

Objectives

- To test the hypotheses that, during manual-wheelchair foot propulsion forward on smooth level surfaces, lowering the seat height increases speed, push frequency and push effectiveness, and decreases perceived difficulty.

Results

- WST capacity scores were reduced at the higher seat heights.
- Negative relationships between seat height and speed (p < 0.0001) and push effectiveness (p < 0.0001) (Figure 1). Lowering the seat height by 5.08 cm from “neutral” corresponded to improvements in speed of 0.20 m/s and in push effectiveness of 0.20 m/cycle.
- The trend for push frequency was also significant (p = 0.003) but the effect size was smaller (Figure 1).
- Perceived difficulty increased with seat height (p < 0.001).
- The video-recordings provided qualitative kinematic data regarding the seated “gait cycles”.

Figure 1. Wheelchair speed, push frequency and push effectiveness, plotted against seat heights (expressed as a percentage of the lower-leg length). Spaghetti plots of the individual participants values are shown. The bold line in each plot is a smoothing function using a mixed-model smoothing technique (cubic spline)

Conclusion

During manual-wheelchair foot propulsion forward on smooth level surfaces, lowering the seat height increases speed and push effectiveness, and decreases perceived difficulty.

References


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