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Impact of camber on rear wheel kinetics for MWC sports

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INTRODUCTION:
Manual wheelchair (MWC) sports require athletes to apply strong repetitive forces on the handrims to accelerate, turn or stop. For many MWC sports, manoeuvrability is critical to performance and, to this extent, the MWC configuration is usually modified by adding camber to the rear wheels. However, rolling resistance was observed to increase with camber (1). Besides, if the interest of camber on shoulder load was already shown, questions remain on the resulting power output at the wheel. This study aims to evaluate the maximum power produced by the user during propulsion for two MWC configurations, with and without camber, using a wheelchair ergometer.
METHODS:
Five able-bodied participants were tested on a fully adjustable wheelchair ergometer equipped with 6-axis sensors on the handrims and velocity-controlled wheels. Seat height and fore-aft position were set as recommended for each subject (2,3). Camber angle was tested at 0 and 15° while keeping the other configuration parameters - and thus the joint configuration with the hand at the top dead centre of the handrim - strictly identical between the two configurations. For each configuration, participants were asked to apply maximum force on the handrims (x5) while wheels were turning at equivalent linear velocities of the MWC of 0.15, 1.0, 1.5 and 2.75 m/s, performed in a randomized order. The maximal propulsive moment was identified for each velocity in each configuration, and a linear regression was performed to identify the moment-velocity profile (4). Finally, the maximal theoretical power was derived from the power-velocity profile for each participant in each configuration (4). Results were compared between configurations with a Wilcoxon signed rank test.
RESULTS:
Maximal propulsive moment was higher for all tested velocities in the configuration with camber (from 39.3±11.1 N.m at 0.15 m/s to 12.2±2.7 N.m at 2.75 m/s) than without (from 38.0±13.3 N.m at 0.15 m/s to 10.5±2.3 N.m at 2.75 m/s) but with no significative difference between the two ($p>0.1$). The maximal theoretical power was different between configurations (160.6±8.6 W with camber, 142.8±23.3 W without) with a 10% significance level ($p=0.06$).
CONCLUSION:
Despite a higher rolling resistance with increasing camber, power output seems to be greater with camber than without. Indeed, the significance level of the difference in maximal power between configurations is above but close to 5%, which could be due to the small number of participants. Therefore, performance should not be impacted by adding camber to the wheels, especially linear acceleration. Moreover, these first results have proven the feasibility of testing and evaluating different configurations in similar velocity conditions, which could lead in the future to further tests with more modifications on the configuration and more velocity conditions.
REFERENCES:
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Topic: Biomechanics

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