Precision And Accuracy Of A Wheelchair Wheel Rolling Resistance Measurement System To Predict Wheelchair Rolling Resistance

Holly Wilson-Jene (University of Pittsburgh) < how34@pitt.edu>
Jon Pearlman (University of Pittsburgh) < jpearlman@pitt.edu>
Rachel Cowan (University Of Miami) < recowan@uabmc.edu>

Introduction: Clinical guidelines recommend minimizing high load and repetitive strain due to risk of UE injury and pain for manual wheelchair users (MWU), and for that reason, minimizing rolling resistance (RR) during the provision process is important to minimize the risk of repetitive strain injury. Reducing load and the duration of load are important recommendations for preserving physical function and mobility, and avoiding functional limitations. Although minimizing RR is important, there is currently no tool to evaluate and optimize RR for the personal characteristics and needs of the MWU during the provision process. To develop this tool, RR forces at a component level (e.g. per-wheel) are needed to calculate RR forces for a range of personalized MWC configurations of the wheelchair. An important step in the development of the tool is to understand how component level RR compares to system level testing, which is currently the standard for assessing RR. This work helps accomplish that step by assessing the precision and accuracy of component level testing compared to system level tests.
Methods: The RR of N=144 unique wheelchair-user setups measured during system tests were compared to the system-level RR calculated

from component tests. The N=144 represented unique combinations of two casters types, two caster diameters, two rear wheel types, two rear wheel diameters, three loads, and three front-rear load distributions. Intraclass correlation (ICC) 95% confidence interval and Bland Altman plots were used to compare RR between the two methods.
Results: The ICC was 0.93 with 95% confidence interval (0.91-0.95). Component based estimates of system RR were systematically higher than system based estimates (Δ+3.4N, standard deviation: 1.0N) and the 95% limits of agreement (LOA) [1.5 to 5.4 N] indicates approximately +/-2.0N predictions of system level RR. Bland Altman plots indicate differences in RR forces are fairly constant over a wide range of test conditions and RR forces.
Conclusion: A strong correlation between methods indicates that component-level testing strongly predicts system-level RR.