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ABSTRACTS FROM CONFERENCE PRESENTATIONS (2003 – 2005)

Energy expenditure and propulsion characteristics during pushrim-activated power-assisted wheelchair propulsion following battery power failure. Lighthall Haubert L, Newsam CJ, Requejo PS, Mulroy SJ. Submitted to Combined Section Meeting of the American Physical Therapy Association: February 2006, San Diego, CA

Background & Purpose

The push-rim activated power-assisted wheelchair (PAPAW) system offers an alternative mode of community mobility for wheelchair (WC) users. These systems are designed to reduce the demands of manual WC propulsion by providing additional force with the release of the pushrim. In order to assess community independence, however, user ability must be evaluated in the PAPAW with the power assistance turned off as these systems add considerable weight to a standard WC. Thus, the purpose of this case study was to investigate the effect of PAPAW battery power failure on oxygen (O_2) consumption and propulsion characteristics in an individual with C7 tetraplegia.

Case Description

A 39-year old man with C7 complete tetraplegia for 17 years propelled his customary WC and 3 commercially available PAPAWs in a power on (PAPAW-ON) and power off (PAPAW-OFF) condition. The subject propelled his own manual WC (Quickie GPV [40 #]) and 3 PAPAWs (iGLIDE [53 #], Xtender [55 #], and e.motion [72 #]) on separate test days. Rate of O_2 consumption was measured during 20-minutes of propulsion over a 126-meter outdoor track at a self-selected pace using the COSMED Portable Gas Exchange system (Cosmed K4b^2). The initial 7 minutes of PAPAW propulsion occurred without battery power (PAPAW-OFF). Average O_2 consumption was determined from every breath sample recorded after 3 minutes of each test condition. Distance and push frequency were recorded during separate 1-minute intervals to determine average cadence, cycle length and propulsion speed. The cost of O_2 consumption (ml/kg*m) was calculated from the ratio of the rate of O_2 consumption (ml/kg*min) and propulsion speed.

Outcomes

Average propulsion speed during each PAPAW-ON condition (93-96 m/min) was similar to that recorded in the subject's customary WC (95 m/min). Cost of O_2 consumption was lower during the 3 PAPAW-ON conditions (0.077 to 0.094 ml/kg*m) compared with that recorded while propelling his customary WC (0.117 ml/kg*m). During PAPAW-OFF conditions, speed was most substantially reduced for iGLIDE and Xtender (73 and 74 m/min, respectively) as a result of decreased cadence. In e.motion, propulsion speed was only moderately reduced (85 m/min). Energy cost during PAPAW-OFF propulsion (0.111 to 0.129 ml/kg*min) was similar to that recorded with the subject propelling his customary manual WC.

Discussion

This individual with C7 tetraplegia was able to propel successfully during the PAPAW-OFF condition using a slower propulsion speed without the penalty of a greatly increased cost of O_2 consumption. The high propulsion speed recorded in his customary WC, however, indicates a higher functioning WC user on level ground. For more marginal WC users, the distance and terrain of propulsion should be considered with the power off. Variations in speed and O_2 cost between the 3 PAPAW-OFF conditions likely relate to the differences in mechanical efficiency of maintaining propulsion speed over level ground.

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