Wheels

A short term paired outcomes study of maneuverability and energy cost of rolling of two pediatric wheelchairs designed for less-resourced settings

Karen Rispin , Taylor Geyman, Sam Nemati (LeTourneau University)
Joy Wee (Queens University)

Introduction

Clinical outcomes measures on the function of assistive devices allow effective targeting of limited funds[1]. In low income countries, because of fewer resources and the low frequency of visits to clinics, outcomes measures are even more necessary[2,3]. Without such feedback, even with the best of intentions, providers can only design pediatric wheel chairs for these settings based on educated guesses.

The goal of the Wheels project is to provide independent studies on the functionality of wheelchairs designed for less resourced settings. Long-term comparative field studies are being done in Kenya; each field study includes a parallel study done in the US using able bodied subjects to investigate the energy cost and maneuverability for subjects who push the wheelchairs. This particular US based study involves the Regency pediatric wheelchair, and a pediatric wheelchair made by the Association of the Physically Disabled of Kenya (APDK).

1. Fuhrer MJ. Am J Phys Med and Rehab. 80(7). 528-35. 1999.
2. International Classification of Functioning Disability and Health (ICF). World Health Organization 2001.
3. World Health Organization. 2008. Guidelines on the provision of Manual Wheelchairs in less resourced settings.

Methods

A comparative study was performed on two supportive pediatric wheelchairs with 12" wide seats, the Regency chair and an APDK chair. The Regency chair is manufactured in the US and distributed around the world by Joni and Friends International Disability Center. The APDK chair is manufactured and distributed in Kenya. (Figures 1,2,3). Subjects were pairs of able-bodied students: high school students pushing elementary school students . Analysis using paired t tests highlights the strengths and weaknesses of each device[1]. Each subject pair completed outcomes measures for one wheelchair, and then the other. Energy cost was assessed by a six minute timed walk test (TWT) with a concurrent Physiological Cost Index (PCI) completed on a sidewalk (smooth ground) and on a gravel driveway (rough ground)[2] (Figure 1,2). Maneuverability was assessed with three skills tests taken from the Wheelchair Skills Test[3]. The Wheelchair pusher completed a visual analogue scale question for subjective input on each of the five exercises. Informed consent, assent, and ethics approvals by all concerned organizations were obtained.

1.Altman BM, Barnartt SN. 2006. Research in Social Science and Disability Vol4: International Views on Disability Measures: Moving toward comparative measurement. Elsevier JAI Press, the Netherlands
2.Makino K, Wada F, Hashisuka K, Yoshimoto N, Ohmine S. 2005. Speed and physiological cost index of hemipelegic patients pedaling a wheelchair with both legs. J. of Rehab. Med. Vol 37. pp. 83-86.
3.Kirby RL, McDonald B, Smith C, McLeod DA, Webber A. 2008. Comparison of a tilt in space wheelchair and a manual wheelchair with a new rear antitrip device. Arch. Phys. Med. Rehabil. Vol 89. P. 1811-1815.

Results

Paired t tests indicated significant differences between the two wheelchairs for the PCI taken while rolling on rough ground and while rolling on smooth ground (table 1). Question results echoed PCI findings for the energy cost of rolling on rough and smooth ground. Question results were also significantly different for maneuvering in tight spaces (a figure eight around two chairs) (table 3). In all of the above, the Regency wheelchair outperformed the APDK wheelchair.

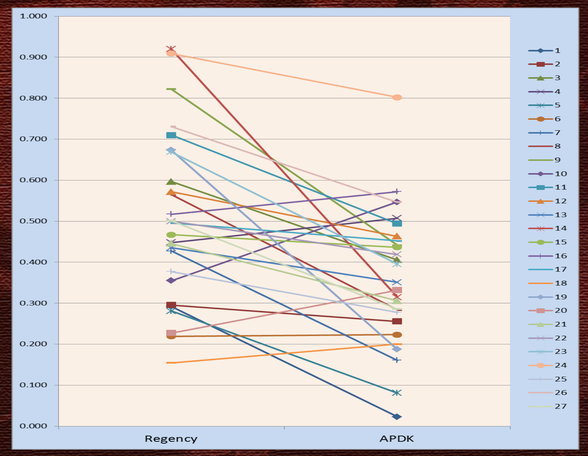

Figure 4. Paired physiological Cost Index results for the energy cost of pushing the two wheelchairs on smooth ground.

Discussion

The skills tests for tight spaces curb and ramp consisted of timing eight iterations of each skill. This may have been too few iterations to enable sufficient sensitivity to differentiate between the two wheelchairs.
Subjects comments indicated that the smaller wheels and the often misaligned and smaller frame made the APDK wheelchairs significantly more difficult to push. In addition, the pneumatic tires of the APDK chair went flat multiple times over the short period of the study. Findings in the larger field study done in Kenya echo these results. APDK is responding to these findings and has expressed eagerness to improve their service to people receiving their wheelchairs in Kenya.

Figure 1. Subjects completing the energy cost assessment on rough ground.

Table 1. Results for the physiological Cost Index on rough and smooth ground tests.

PCI (see table 2 for formula)	Regency median	APDK median	T-test significance
Rough ground	0.524	0.652	0.025
Smooth ground	0.351	0.495	< 0.001

Table 2. Formula for the physiological cost index.

Mean exercise heartrate - Mean resting heartrate/Walking speed

Table 3. Results from visual analogue scale questions. Each item was rated from 0 "poor" (with a sad face emoticon) to 100 "excellent (with a happy face emoticon).

Rate how well this wheelchair helps you to:	Regency median	APDK median	T-test significance
Go up and down a curb	59 mm	57 mm	Not significant
Move in tight spaces	85 mm	75 mm	0.01
Go up and down a ramp	70 mm	69 mm	Not significant
Move on smooth ground	94 mm	82 mm	0.001
Move on rough ground	70 mm	50 mm	0.001

Figure 2. Subjects completing the energy cost assessment on smooth ground in the APDK 12" wheelchair

Figure 3. Subjects completing the curb skill test with the Regency pediatric wheelchair