



A Long-term Paired Outcomes Study of Two Pediatric Wheelchairs Designed for Less-Resourced Settings

Karen Rispin, Taylor Geyman, Samuel Nemati, Joy Wee
LeTourneau University, Queen's University

I, Karen Rispin, do not have an affiliation with an equipment, medical device or communications organization.

In low-income settings, available equipment such as low-cost wheelchairs need appropriate assessment of effectiveness. Clinical outcomes measures allow effective targeting of limited funds¹. The Wheels Project is developing a low technology suite of validated outcomes measures suitable for paired comparisons of wheelchair utility within the framework of the International Classification of Functioning, Disability and Health (ICF)², suitable for administration in less resourced settings. There is a felt need for feedback to wheelchair manufacturers and distributors in low-income settings in order to improve design and processes³.

Our study compares the Regency Pediatric wheelchair distributed by Joni and Friends Relief and Rehabilitation International, and the 12-inch special pediatric wheelchair made and distributed by the Association of the Physically Disabled of Kenya. The research was done through a partnership with BethanyKids in Kenya. Results presented include energy cost, maneuverability, participation and social significance, as well as feedback from seating specialists for each wheelchair model. Through this study BethanyKids personnel benefit from training in fitting and maintaining wheelchairs while children with disabilities benefit by receiving appropriate wheelchairs³. APDK and Joni and Friends will benefit from objective feedback to inform design.

Methods

Energy cost and maneuverability:

Twenty seven children with disabilities who were accustomed to wheelchairs and able to self-propel well completed the suite of measures once for each type of wheelchair: a six minute Timed Roll Test (TRT) on rough ground and on smooth ground wearing polar pro R 400 heart rate monitors; Physiological Cost Index (PCI) was calculated for rolling on each surface^{5,6}. The following skills taken from the Wheelchair Skills Test⁷ were performed 15 times in succession and timed: up and down a ramp, up and down a low curb; and a figure eight around two chairs placed 70 cm apart on a smooth surface. For each of the measures, user feedback in the form of a Visual Analogue Scale question was also obtained. Data for each test for the two wheelchairs were compared using paired T tests.

Questionnaire feedback from wheelchair users: Twenty children who had been using the Regency pediatric wheelchair completed a Visual Analogue Format version of the Functioning Every day in a Wheelchair (FEW) questionnaire with two participation questions added⁸. Each question also sought narrative explanation for any negative response. We had planned to have all subjects use the APDK chair for a week and complete the questionnaire again for that wheelchair. A RESNA certified seating specialist determined that only 13 of the 20 children who had been using the Regency wheelchair were able to safely use the APDK wheelchair for a week; 5 were too tall and 2 had other difficulties. Several children asked to be moved out of the APDK wheelchair after one, two or three days use. We had these children complete the questionnaire for the APDK wheelchair and their data is included even though the duration of use was shorter.



Questionnaire feedback from therapists: Each seating specialist, technician and therapist working with the wheelchairs completed a questionnaire on the design of 11 structural regions of the wheelchair plus 7 additional questions on the likelihood of the wheelchair's performance in various categories. Once again, a VAS format was utilized and comment explaining negative responses solicited. All completed the same form for both chairs enabling paired data analysis. The maintenance condition of each region of each of the 30 study wheelchairs was assessed by a RESNA certified seating specialist responding to a VAS format questionnaire.

Ethics approval: Subject consent and assent forms and research protocols for this study were approved by the ethics committees of LeTourneau University, Bethany Kids Relief and Rehabilitation and Queens University. A letter of support was also provided from the Kenyan Ministry of Medical Services.

Results

For the energy cost and maneuverability data, paired T tests indicated that children traveled significantly farther in six minutes on both rough and smooth ground in the Regency wheelchair than in the APDK wheelchair. Children also took significantly fewer seconds to travel up and down a low curb fifteen times in the Regency wheelchair than in the APDK wheelchair.

For the questionnaire feedback from wheelchair users all significant differences again favored the Regency wheelchair. In six of nine FEW questions, the users rated the Regency chair significantly higher. Both chairs received lower ratings on the question concerning traveling outdoors; children commented that the castors would stick and twist on rocks and holes. The Regency chair received statistically higher ratings for the participation question concerning ability to play with friends. Insight into the children's own priorities for wheelchair function is available through the explanations offered by the children for any negative response. Children expressed concerns to do with the design of the foot plate/front rigging of both wheelchairs, and concerns that were related to the tray function of both chairs.

Feedback on design from therapists indicated that there were significant differences favoring the Regency wheelchair in four of eleven structural regions, and five of seven functionality questions. In most of the categories in which there was no significant difference between the two wheelchairs, both wheelchairs had relatively high ratings with two exceptions, both wheelchairs received lower assessments for footplate function and seat back adjustability.

Feedback on Maintenance showed significant difference in the condition of four of eleven structural regions of the wheelchairs with Regency receiving higher ratings on wear in two regions and APDK receiving higher ratings in other two. The Regency chairs had been in use for eight month, and the APDK chairs for less than two weeks. Comments indicated that the APDK chairs had repeated flat tires, misaligned wheels, footplate interference with castor function, and cushions permeable to urine and bottoming out. In spite of eight months of hard use, all of the Regency wheelchairs were still in use. Several trays had broken, wheel locks had become stiff and several footplates had broken. The waterproof vinyl covers on the cushions and the cushions themselves had, in general, held up well though a few needed replacement. The tires and castors also held up very well.



Discussion

The lack of significant difference between the two wheelchairs for the Physiological Cost Index for the Kenyan children may be because the children were choosing to roll at velocities that enabled a similar physiological cost. This study was in conjunction with one done in Texas concerning the energy cost and maneuverability of the same wheelchairs for high school students pushing elementary school students. The same tests for energy cost and maneuverability were used. In that study, there was no significant difference in the Timed Roll Test; however there was a significant difference in the PCI results for rolling on rough and smooth ground with physiological cost being higher for the APDK wheelchair. Apparently the able-bodied high school students were willing to sustain a higher physiological cost to walk about the same speed with the two wheelchairs. We are developing a rolling constant speed device which the children can follow in future studies to clarify differences in physiological cost. In future studies we are planning to calculate the physiological cost of the maneuverability exercises as well because some of the children seemed to enjoy racing, pushing themselves hard to do the tests quickly.

For the therapists, as for the children, many of the comments accompanying low rating for the APDK chair seemed to be due to issues related to manufacturing and materials. For example wheels were often misaligned; frames were often not symmetrical; bolts stripped easily on the foot plate adjustment causing the foot plate to fall into the castors, and tires went flat very frequently.

APDK has been very open to feedback from this study and has expressed interest in doing what is necessary to improve difficulties. Joni and Friends has also been responsive. We are encouraged that this study and studies like it may have a positive long term effect on wheelchair provision in less-resourced settings.

References

1. Fuhrer M. Assistive technology outcomes research: challenges met and unmet. *Am J Phys Med and Rehab.* 1999; 80(7): 528-35.
2. International Classification of Functioning Disability and Health (ICF). World Health Organization, 2001.
3. Guidelines on the provision of Manual Wheelchairs in less resourced settings. World Health Organization, 2008.
4. Altman B, Barnartt S. International Views on Disability Measures: Moving toward comparative measurement. *Research in Social Science and Disability Vol4.* Elsevier JAI Press, the Netherlands. . 2006.
5. Enright P. The Six-Minute Walk Test. *Respiratory Care.* 200;48:783-5.
6. Cress E, Kinne S, Patrick DL, and Maher E. Physical functional performance in persons using a manual wheelchair. *Journal of Orthopaedic & Sports Physical Therapy.* 2002; 32:104-13.
7. Kirby L, Swuste J, Dupuis D, MacLeod D, and Monroe R. The Wheelchair Skills Test: a pilot study of a new outcome measure. *Arch Phys Med Rehabil.* 2002;83:10-8.
8. Mills T, Holm M, Treffer E, Schmeler M, Fitzgerald S, Boninger M. Development and consumer validation of the Functional Evaluation in a Wheelchair (FEW) instrument. *Disabil Rehabil.* 2002. 24(1-3):38-46.

