AN OVERVIEW OF A GROUP OF STUDIES DONE IN KENYA COMPARING TWO TYPES OF PEDIATRIC WHEELCHAIRS WITH 14 INCH WIDE SEATS

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ABSTRACT

At a primary school for children with disabilities in Kenya, two types of wheelchairs of similar size were fit to students based on medical need. After the chairs had been in use for three months, subjects were enrolled and data collection including professional report, user report and performance tools was completed. For subject report the Functional Mobility Assessment, modified for pediatric use, was completed by 31 subjects. For performance assessment, a suite of seven skills was conducted in one type of chair and then the other by 28 strong self-propelling wheelchair users. For the professional report aspect, a certified and experienced clinician rated the maintenance condition of the parts of each study chair, and thirteen clinicians rated the design of each make of study wheelchair. ANOVA analysis indicated significant differences between the two types of chairs with one type of chair outperforming the other in all statistically significant results. Descriptive statistics indicated strengths and weakness of both types of wheelchairs. Data was presented to the manufactures who have indicated that they will be responding to this research with design updates.

BACKGROUND

The landscape for the provision of wheelchairs for less-resourced settings has been changing as additional non-profit organizations have made a directed effort to build and distribute wheelchairs designed specifically for these settings (Pearlman et al., 2008; USAID/WHO, 2012a). These wheelchairs are most often provided as a somewhat adjustable unit composed of a seating system and base (USAID/WHO, 2012b). Economics would seem to indicate that the lower the cost of manufacturing, the more people with disabilities can receive a wheelchair. However, the pressure to produce a low cost chair must be balanced against the need to produce a robust, adjustable and culturally appropriate design that minimizes clinical complications (Borg & Khasnabis, 2008; Borg, Lindström, & Larsson, 2011). With this in mind, feedback from objective field studies set in low resource settings are of crucial importance (Borg & Khasnabis, 2008).

Outcomes measures have been categorized as self-report, professional report and performance instruments; for insight into the function of a make or type of wheelchair in all ICF categories, all three types of outcomes are necessary; Robust and simple data collection instruments are more likely to function well in challenging settings. (*Towards a Common Language for Functioning, Disability and Health: ICF*, 2002).

Outcomes measures designed to produce continuous and statistically normal data are more likely to highlight strengths and weaknesses and differentiate in comparative studies through the use of more sensitive parametric statistical analysis tools (Dytham, 2011). When collecting outcomes data there is always a tension between complete data and data that can reasonably be obtained given limitations of time, tools and researchers skills; this is especially so in low resource settings (Jefferds et al., 2010).

Performance tools for wheelchair evaluation are often called skills tests and include timed and physiological assessment of activities used in daily life; almost all of these include rolling on different surfaces, over curbs, through tight spaces and transfers (Fliess-Douer, Vanlandewijck, Manor, & Van der Woude, 2010). Some studies also include wheelies which are a skill of special interest when navigating rough or uneven surfaces (Kirby, Smith, Seaman, Macleod, & Parker, 2006). Because human variation is especially high in populations with disabilities, to simply collect data on the performance often merely tells the researcher that the subjects are different from each other. However, a paired with-in subjects protocol minimizes the impact of this variation and reveals the strengths and weaknesses of each assistive device (Best, Kirby, Smith, & Macleod, 2006).

Wheelchair design and maintenance condition is known to impact the performance of wheelchair users and consequently their participation and ability to carry out the tasks of daily life (Gorce, 2012). There seemed to be very few validated professional report tools available on wheelchair design or condition; professional report tools for wheelchair assessment most often seem to be descriptive or categorical and aimed at assessing the appropriateness of a wheelchair for individual users (Batavia, 2009; Karmarkar & Cooper, 2009).

The Functional Mobility Assessment, a self-report tool for wheelchair users, modified to visual analogue format with emoticons for pediatric use provides a simple and robust means of obtaining user reported outcomes on the impact of a wheelchair on human function (Kumar et al., 2012; Rispin, Schein, & Wee, 2013).

PURPOSE

The purpose of these comparative studies was to provide feedback to the manufacturers of wheelchairs designed for low resource settings by addressing the following issues:

1. Performance outcomes indicate energy cost and ease of movement on rough and smooth ground, over curbs, in tight spaces, on ramps, wheelies and for transfers to the ground.
2. Professional report outcomes rate durability and design of the structure of the chairs.
3. User report outcomes rate wheelchair function in daily activities.

We hypothesized that this data would provide feedback to assist wheelchair providers and manufacturers to better serve wheelchair users.

METHODS

Host organization

A relationship was built with a host organization which has an agreement to provide rehabilitation for students attending a boarding school for children with disabilities where they facilitate the provision of wheelchairs and oversee the fitting of wheelchairs. This study was able to facilitate the provision of wheelchairs and the provision of training for therapists. Our subjects were drawn from the population of students using wheelchairs served by our host organization at the boarding school. All students using study wheelchairs at the boarding school received wheelchair skills training.

Ethics Approval

Study protocol was approved by all involved organizations including LeTourneau University, Queens University, and our host organization, registered, and cleared with the Kenyan Ministry of Medical Services. Subject assent and consent was obtained from all subjects and their guardians.

Wheelchairs

Two types of pediatric wheelchairs with 14 inch wide seats, and seating systems that included removable headrests and lateral supports were included in this study.

Twenty-five Hope Haven KidChairs were shipped to our host organization from Guatemala. This chair was originally designed by a group of engineering students from Dort University in response to a request for a pediatric chair which could be assembled without welding; metal tubing is joined by blocks of composite material. Ten wheelchairs made by the Association of the Physically Disabled of Kenya (APDK) were provided by APDK. This Kenyan-built chair is roughly based on a Whirlwind design.

The chairs were fit to students at a boarding school for children with disabilities based on medical need and following the World Health Organization guidelines (Borg & Khasnabis, 2008).

Outcomes Measures

Measures were chosen that were simple to use and we believed would likely result in normal data to enable the use of parametric statistics for more sensitive discrimination of meaningful differences.

For performance outcomes, subjects completed seven skills in one make of wheelchair and then the other. Timed tests and physiological cost index were calculated in five measured tracks: over smooth ground, rough ground, curb, ramp, and figure-eight. Timed tests alone were completed for transfer to the ground and back three times, and the ability to hold a wheelie for 30 seconds. Within subjects design was used to minimize the impact of individual variation due to differing disabilities and fitness levels.

For user report, the ten question Function Mobility Assessment modified for pediatric use was completed.

For professional report on durability, a specialist rated the condition of 11 parts and the overall condition of each study wheelchair after three months of use.

For professional report on design, clinicians rated the design of 11 parts of each wheelchair type, the overall design and the "likelihood" that the wheelchair would serve well in 7 conditions of use. A within subjects design was utilized to minimize the impact of the variation due to the differing backgrounds of the clinicians.

Subjects

For performance outcomes subjects were 28 students (age 12 ± 3. 19 M, 9 F) identified by caregivers as able to self-propel strongly on rough ground. Disabilities were diagnosed as follows: 14 spina bifida, 4 spinal injuries, 3 congenital malformations, 3 osteogenesis imperfecta, 2 amputees, 1 cerebral palsy and 1 arthrogryposis.

User report outcomes subjects were 31 children (mean age 11 ± 3, 17 M. 18 F) who had been using the study wheelchairs over a period of time. They had been fit to the wheelchairs based on medical need and subsequently joined the study. Disabilities were diagnosed as follows: 12 cerebral palsy, 9 spina bifida, 3 muscular dystrophy, 2 tuberculosis of the spine, 1 amputee, 1 spinal injury, 1 arthrogryphosis and 1 paraplegia.

Professional report on wheelchair design was provided by14 clinicians who had worked extensively with the wheelchairs.

Professional report on wheelchair condition was provided by a clinician who was an Assistive Technology Professional and a Certified Rehabilitation Technologist with 22 years of pediatric experience.

Data Analysis

Data was tested for normality using the Shapiro-Wilks test. Descriptive statistics were calculated for all outcomes.

Within subjects ANOVA analysis with post hoc t-tests were utilized for the performance tests and the professional report data on design.

Between subjects ANOVA analysis with post hoc t-tests were utilized for the user report FMA questionnaire and the professional report data.

RESULTS

Performance: Within subjects ANOVA analysis and post hoc t-tests indicated that the Hope Haven chair enabled subjects to move significantly more quickly over rough and smooth ground, around a figure 8 track and on a ramp. However the physiological cost index did not significantly differ between the two chair types except for on smooth ground where the Hope Haven chair enabled a lower physiological cost of rolling than the APDK chair. Subjects completed three transfers to the ground and back significantly more quickly in the Hope Haven chair than the APDK chair. Eleven subjects were able to hold a wheelie for 30 seconds in the Hope Haven chair, while only 3 were able to do so in the APDK chair.

User report: Four of the 35 study wheelchairs did not have users who joined the user report study; the users of these chairs were absent from the boarding school for various reasons; three were users of APDK chairs and one used a Hope Haven chair. Because there were only 7 subjects who were using APDK chairs for the user report study as compared to 24 subjects using the Hope Haven KidChair, statistical power was not adequate for meaningful between subjects comparative ANOVA analysis for the FMA questionnaire data. However, descriptive statistics from the FMA for the Hope Haven chair were statistically robust. For that type of chair, user ratings were especially high for the question regarding rolling indoors and lower for the question regarding rolling outdoors. Diagnosis seemed to impact ease of use, for it was observed by the third author that some children with muscular dystrophy who were unable to maneuver the Hope Haven wheelchair were able to use the APDK chair at initial fitting.

Professional report on wheelchair design: Within subjects ANOVA indicated that clinicians rated the design of the Hope Haven chair significantly more favorably. Post hock t-tests indicated the differences were especially marked for the laterals, wheel-locks, overall design, and its likelihood to function well to prevent pressure sores, for play and for users who self-propel. Comments indicated that the clinicians felt manufacturing quality control was an issue for the APDK chair. Descriptive statistics indicated that both types of wheelchairs were rated poorly for the design of the front rigging foot plate.

Professional report on wheelchair condition: The wheelchair users of study chairs who were absent from the school had left their wheelchairs at the school enabling all of the 35 study chairs to be included in the professional report wheelchair condition study. Many of the wheelchairs had no head rests or laterals because their users did not require these parts. The questions including these parts were therefore not included in ANOVA analysis. Between subjects ANOVA analysis indicated that the two groups of chairs were statistically different in condition after three months of use. Post hoc t-tests indicated that the difference was especially pronounced in the condition of the seat back, the seat and the wheels. The clinician's comments indicated that on the APDK chair the tires were very often flat, the seat and seat back the fabric was more often cracked and torn and the cushions collapsed.

DISCUSSION

The simple protocols enabled data collection to be successfully carried out in a challenging low resource environment. Three of our four sub-studies did successfully differentiate between the two types of wheelchairs highlighting strengths and weaknesses of the two chairs. All four types of data collection gave robust descriptive data.

Our results would seem to indicate that if there was an opportunity to choose between providing a child with a Hope Haven chair or an APDK chair, in many circumstances, a Hope Haven chair would be preferred. Its lower energy cost of rolling was especially pronounced on smooth surfaces where it enabled a higher velocity and lower physiological cost. Though it still significantly enabled the users to travel more quickly on rough surfaces, the difference was not as pronounced and there was not a significant difference in the physiological cost index. The Hope Haven chair also enabled significantly quicker transfers to the ground and back, a common task that we were told children at the boarding school may do up to a dozen times a day. In spite of the fact that the subjects for the performance tests were strong, less than half could hold a wheelie for thirty seconds in the Hope Haven chair and only a few in the APDK chair. In both wheelchair types, it seemed that the axle was set well behind the center of gravity increasing the difficulty of holding a wheelie.

Professional report tools produced data on that seemed to be of special interest when we presented our findings to the wheelchair manufacturers. Manufacturers indicated that it was especially valuable to know which parts of the chair often failed over time. They also indicated that they found the feedback on design from Kenyan and American clinicians with experience in the field valuable. The Director of Operations for Hope Haven International had traveled to Kenya to be present at the end of the data collection period. APDK invited him to a meeting at which we were able to present preliminary data. It was rewarding to hear the two organizations discussing sourcing and sharing insights.

Study Limitations

The lower number of APDK chairs and the low number of children fit with APDK chairs who enrolled in the user report aspect of the study resulted in weaker statistical power for the that aspect of the study. The tenth question in the FMA concerns the ease of transporting a wheelchair in a motor vehicle. Because most of our subjects had never done this, the tenth question was not included in our study.

CONCLUSION

The results of these studies may have a broad impact on wheelchair provision in Kenya and other countries as the manufacturers of the study wheelchairs respond with design and material changes. Their response may positively impact all of the future users of their wheelchairs around the globe.

The results of these studies also have clinical implications for our partner organization and other wheelchair providers as they select between available wheelchairs. It may have information of interest to those who fund wheelchair provision in low resource settings.

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