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Research Article

Wheelchair skills training programme for children: A pilot study

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***Aim*:** *Wheelchair skills are not typically provided when a child gets a new wheelchair. The purpose of this prospective pilot study was to determine the effectiveness of a two-day modified Wheelchair Skills Programme 3.2 for children.*
***Methods*:** *Six children (ages 6–19 years) with spinal cord injuries or spina bifida were invited to participate in a two-day wheelchair skills programme provided on subsequent Saturdays. Children were tested before and after training using a modified Wheelchair Skills Test 3.2. To assess for the effect of the programme on participation, the Activity Skills for Kids was used before and one month after training. For a more qualitative reflection, an Impact Questionnaire was given at four months post-training.*
***Results*:** *There was a significant (14%) increase in skills based on the Wheelchair Skills Test 3.2. No change in participation was measured with the Activity Skills for Kids. The Impact Questionnaire suggests the skill training allowed participants to do more, with less pain and fatigue post-training.*
***Conclusions*:** *A two-day wheelchair skills programme can potentially improve skill level in children with spinal cord injuries or spina bifida.*

Significance of study

- Wheelchair skills programmes for children appear to be a promising method for teaching necessary skills.
- Further investigation of short- and long-term effects of wheelchair skills programmes on participation are required.
- We advocate further investigation of training of wheelchair skills to children.

Introduction

Children who use wheelchairs often do not have the same opportunities to participate as children without wheelchairs, particularly in the areas of social interaction, opportunities for independent play, and exploration and independent mobility (McConachie, Colver, Forsyth, Jarvis & Parkinson, 2006). There has been a great deal of information about the benefits and need for early powered mobility (Berry, McLaurin & Sparling, 1996; Evans, Neophytou, de Souza & Frank, 2007; McDonald, Surtees & Wirz, 2004; Staincliffe, 2003), and a general consensus that if children are able to have independent mobility that there is a positive effect on development (Furumasu, Guerette & Tefft, 2004; Huhn, Guarrera-Bowlby & Deutsch, 2007). Children's ability to engage in meaningful occupations are greatly enhanced by their ability to explore their environment independently (McConachie *et al.*). However, literature in this field has tended to concentrate on either powered mobility or mobility of children with cerebral palsy rather than on those who may independently use manual wheelchairs (Butler, 1986; Wade, 1994a, 1994b). We searched the literature using Medline, Cinahl, Google Scholar and hand searching in order to identify and critique relevant literature. We found that literature on adult wheelchair skills acquisition is well developed, but none of this has yet included children (Best, Kirby, Smith & Macleod, 2005; MacPhee, 2004; Kilkens, Post, van Asbeck & van der Woude, 2005). It is therefore important to investigate this area as there is no existing evidence base on which to base good practice.

Development and measurement of wheelchair skills is seen as an important part of rehabilitation for adults who have acquired mobility impairment (Fleiess-Douer, Vanlandewijck, Manor & Van Der Woude, 2010). A

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variety of skills are necessary for manual wheelchair users to function effectively, and these skills can make the difference between dependence and independence in everyday life (Hoenig, Landerman, Shipp & George, 2003). However, children are not always afforded the opportunity for instruction, practice and development of skills (Fernandes, 2006).

Wheelchair skills training has received an increase in attention as an important factor in addressing mobility and participation barriers. Kirby (2009) developed a Wheelchair Skills Training programme (WSTP) and a Wheelchair Skills Test (WST) which have been applied to adult populations. Studies have shown effectiveness of the WSTP during the initial rehabilitation of wheelchair users (MacPhee *et al*., 2004), for community wheelchair users (Best *et al*., 2005), and for occupational therapy students (Coolen *et al*., 2004). However, there have been no publications about the use of wheelchair skills programmes or standardized skills testing with children. Wheelchair skills are essential for children's ability to participate as well as for their health and wellbeing both in the short and long term. Secondary injuries such as shoulder, neck and back pain resulting from poor wheeling practice in the long term are documented in both those who began wheeling as adults or as children (Alm, Saraste & Norrbrink, 2008; van Drongelen *et al*., 2006; Kennedy, Lude & Taylor, 2006; Rice, Impink, Niyonkuru & Boninger, 2009; Roehrig & Like, 2008; Sawatzky, Slobogean, Reilly, Chambers & Hol, 2005). Much of this pain can be prevented (Alm *et al*.; Requejo *et al*., 2008; Rice *et al*.) and thus it is essential that children are given the opportunity to access these preventative strategies to enhance their quality of life, freedom from pain and ability to participate in activities both immediately and in the future.

Two programmes targeted for children and youth are available in the United Kingdom. The Association of Wheelchair Children (http://www.wheelchairchildren.org.uk) provides an educational two-day skills programme designed for children who use wheelchairs. The second programme is Whizz kidz (http://www.whizz-kidz.org.uk) which offers similar skills training with 12 hours of training over three to six sessions offered in various cities around England. A third programme in Australia from the Northcott Rehabilitation Centre offers skills training, using their own developed programme, to children from three years of age to late adolescents. They have tried to break-up the skills in regards to developmental stages (de Paula & Watson, 2011). There are no reports in the literature regarding the effectiveness of any of these programmes.

The purpose of this initial pilot study was to determine whether a two-day WSTP would improve children's wheelchair skills, and whether this improvement of skills influenced the children's ability to participate in their home and community environments.

Methods

Participants

The study was aimed at children ages 6–15 years, with a spinal cord disorder or injury; however, one older participant was included on the specific request of the individual and their parent. To be eligible, participants should be part-time (25–50% of their daily mobility) or full-time (100% of daily mobility) manual wheelchair users in stable physical health, and cognitively able to follow two-step instructions as assessed by an occupational therapist. Participants were recruited from the local Spinal Cord Clinic using advertisements in the clinic. We required that at least one parent/guardian to attend the programme with their child. Our aim was to recruit six to ten participants.

Demographic and clinical data

Participants completed a short questionnaire to provide demographic information about their age, gender and disability. Information about wheelchair use was also gathered, including the amount of time using a wheelchair per day, and any previous wheelchair skills training experience.

Outcome measurements

The WST Version 3.2 is an objective test of wheelchair skills (Kirby, 2009) with published psychometric properties (Kirby, Swuste, Dupuis, MacLeod & Munro, 2002; Kirby *et al*., 2004). It has been used in a number of studies (Best *et al*., 2005; Coolen *et al*., 2004; MacPhee *et al*., 2004). The WST evaluates the wheelchair user's ability to perform a range of skills required in everyday life, including indoor skills (e.g. forward and backward wheeling), community skills (e.g. wheeling over gravel and potholes) and more advanced skills (e.g. those involving wheelies).

We adapted the WST 3.2 for the purpose of this study. We removed the items of moving away and restoring the leg rests (left and right) and armrests (left and right), transferring in and out of the wheelchair and folding and unfolding the wheelchair, and wheeling across gravel as the children's chairs did not have these components, or we did not have access to equipment. We adjusted the 15 cm level change to a 10 cm level change and the 5° incline to a 3.5° incline to decrease the difficulty level for the children. We added three other skills that were developmentally appropriate. The first skill, the 'sudden stop', involved wheeling quickly for 3 m and then stopping before a line. The time the casters crossed the line to the time full stop was completed was recorded using a stopwatch. The distance it took them to stop was also measured. The second skill involved righting the wheelchair after it tips over backwards and getting back into the wheelchair. The child and chair were gently placed backwards on the floor and they had to get upright. This

replaced level transfer since kids spend more time getting on and off the floor to play with peers. The third skill was a figure of eight using three cones set 1.5 m apart. The first cone was used as a starting point. The child had to wheel around them without touching the cones. These last two measures were evaluated on successful completion and safety similar to WST protocol. The total score for each child was calculated using a percentage score using successful tasks divided by the number of total items.

The trainer of the programme is an experienced physical therapist, with over 25 years of practice in training wheelchair skills. The WST was divided into seven stations, with one assessor per station. Assessors were occupational therapists or occupational therapy students trained in assessing those skills. During the pre- and post-assessment, the wheelchair users were required to negotiate all skills tested without verbal or physical assistance from assessors. A script was provided for each assessor specifying the instructions for each skill to ensure consistency.

To investigate the potential impact of the programme on participation we used the Activity Scale for Kids (ASK) Performance (Young, Williams & Yoshida, 2000). This 30-item, self-report measure has been shown to be valid and reliable for children 5–15 years of age, able to discriminate between levels of disabilities and has been used in a variety of studies to measure activities and level of participation of children with disabilities (Morris, Kurinczuk, Fitzpatrick & Rosenbaum, 2006; Plint, Gaboury, Owen & Young, 2003; Smith, Owen, Fehlings & Wright, 2005). An example of a question is: 'Last week I got around outside without help'. The response options for each activity use a 5-point ordinal scale. Subsections of the ASK include items such as personal care, dressing, eating, play, locomotion, standing skills and transfers. A total score of all areas or subscores can be calculated. For the purpose of this study, only the locomotion data were extracted and analysed. This was done by the suggestion of the ASK developer. The ASK was completed by the child and parent/guardian together, except for the 19-year-old participant who completed it independently.

To provide additional information about the training experience, an Impact Questionnaire was created by the authors to ask open-ended questions regarding the impact and general usefulness of the training programme. These included: (i) What new or improved skills are you/your child typically using at home or school if any? (ii) Are you/your child more independent in day to day life after the skills training? If yes, how? (iii) Are there any other changes noticed after participating in the wheelchair skills training? (iv) Additional comments? Children and families were also invited to offer any suggestions for improvement to the programme.

Intervention

The WSTP consisted of 9 hours training over two days. It involved the testing of the wheelchair skills (WST) as well as training wheelchair skills similar to the WSTP. The aim was to make the sessions fun for the children. The individual (ID) who led the training programme has over 25 years of teaching experience in wheelchair skills and working with children and is a regular presenter at seating and mobility conferences on the subject.

Participants completed the ASK prior to arrival to the programme. The Wheelchair Skills programme took place over two consecutive Saturdays with a lunch break half way through the day. All the children used their own wheelchairs. During the first day, the WST was administered, followed by skills training. Approximately half the skills were taught the first day. Skills were taught through verbal explanations and with demonstrations, breaking down the components of each skill. This training was given as a group session with lots of encouragement and considerable effort to make the activities fun and enjoyable. In addition, a one hour wheelchair maintenance session was taught for parents while the children observed, during the morning break on the first day.

On the second day, the skills that had been taught were reviewed and new skills were introduced and practiced. The participants' skills were re-assessed using the WST at the end of the second day to avoid another visit. At the end of the programme, the participants were encouraged to continue practicing the wheelchair skills they had been taught. A second ASK questionnaire was mailed out at one month post-training and the Impact Questionnaire was mailed at four months.

Safety

Testers and trainers used proper spotting techniques, including spotter straps. All participants had spotter straps attached to their wheelchairs, and each participant had a spotter with them at all times during assessing, teaching and practicing sessions at the camp for any task in which there was a risk of the participant losing control of the wheelchair or tipping over in it. Adverse incidents were recorded.

Data analysis

The demographic data, WST results and ASK scores were analysed using primarily descriptive statistics. Due to small sample size we completed a Wilcoxon *t*-test using SPSS to compare the pre-/post-WST and ASK scores ($\alpha < 0.05$). However, comparative statistics are not the emphasis of this pilot study. The final Impact Questionnaire was analysed using a qualitative content analysis. Two authors independently examined the data to determine themes that emerged from the answers to the open-ended questions. The results were then compared for consistency.

Ethics

Ethical approval for this study was obtained from both university and hospital clinical research ethics boards.

TABLE 1: *Participant demographic and clinical data*

Parameter	(*N* = 6)
Gender	
M:F	2:4
Age (years)	
Mean (SD)	12.3 (4.5)
Diagnosis of wheelchair user	
Spina bifida	5
Spinal cord injury	1
Length of WC use (years)	
Mean (SD)	6.1 (2.4)
Previous WC training experience	
Watched WC training video	2
Participated in WC sports	1
None	3
Wheelchair usage	
Full-time/part-time	3/3

WC, wheelchair.

Results

Participants

The demographic data from the six participants who completed the initial testing and post-test questionnaires are presented in Table 1. All children were able to participate in both sessions of the training programme. Families of other eligible children reported that they found a two-day programme over the weekends challenging to attend.

Wheelchair Skills Test

The pre- and post-test participant WST scores are illustrated in Figure 1. A higher score post-test indicates an increase in skill development. The pre- to post-WST mean total scores (±SD) increased significantly from 66 (±14)% to 75 (±17)%, respectively, with a mean relative improvement of 13.8% (±9.8), (P = 0.03). These results demonstrated a 14% relative improvement. All of the participants improved their skills, with a relative change in scores ranging from 7% to 33%. The greatest improvement came from the oldest participant. The skills that demonstrated the highest level of skill improvement were the 13 cm obstacle, the wheelie, no-hands-rest against the wall and the 10 cm level change descent. The list of skills and the success rates (%) for individual skills before and after skills training are shown in Table 2.

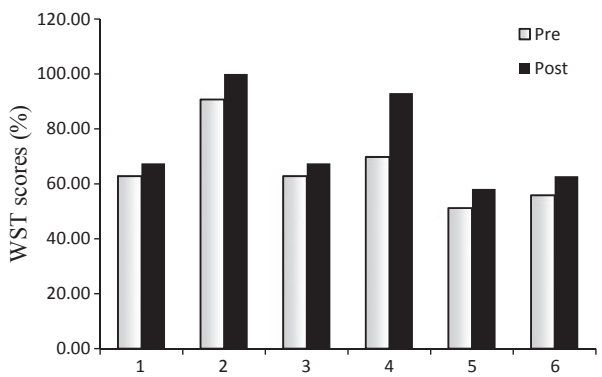

FIGURE 1: *Individual WST Scores pre- and post-training.*

Activity Scale for Kids

For community participation, we used the subscore for locomotion. A higher score indicates greater community participation. Overall the scores decreased pre- (41 ± 6) to post-training (32 ± 8), but were not statistically significant (Fig. 2). Two participants demonstrated no change in their mobility participation scores, whereas four participants demonstrated a small decrease in their scores.

Impact questionnaire

Analysis of the qualitative data from the questionnaire at four months post-training revealed three themes: (i) development of independence; (ii) improvement of wheelchair skills; and (iii) a decrease in shoulder pain. Two example quotes demonstrating development of independence are from a parent, '… is more willing to challenge herself with obstacles independently (small inclines, doors, etc.)' and a child, '… able to be more independent and confident to go out on my own'.

Some example quotes of improved skills included from parents are, '… increased confidence with doing extreme wheelies', '…. can get up ramps and go on slanted surfaces', and '… has had an intense workout to practice wheelchair skills with his young and enthusiastic home care helper and exerciser under physiotherapy supervision and has improved from ideas from the workshop'.

The decrease in shoulder pain and in fatigue were evident by parent comments such as, 'We have noticed that the skills for wheeling... has made a big difference in his right shoulder pain (decreased) and fatigue level when out for walks…' and '… less energy expenditure and able to manoeuvre over small transitions'.

Safety

No physically adverse incidents were reported; however, psychologically one child who had some cognitive challenges was frustrated more easily and would often cry if she was not successful right away.

Discussion

The purpose of this pilot study was to see whether or not a two-day WSTP for children could improve their wheelchair skills and community participation. The results of the wheelchair skills training tests and the Impact Questionnaire were encouraging. The learning process

TABLE 2: *The percentage of participants who completed the skills pre- and post-training using the Wheelchair Skills Test*

Skill	Pre-training WST%	Post-training WST%
Apply right brake (L&R)	100	100
Release right brake (L&R)	100	100
10 m forward roll	100	100
5 m roll backward	100	100
Turn in place right (180°)	100	100
Turn in place left (180°)	100	100
Moving turn forward (L&R)	100	100
Moving turn backward (L&R)	100	100
5 m roll over carpet	100	100
Sideways manoeuvring (L&R)	100	100
Reach for object on the floor	100	100
Reach for high object (1.5 m from floor and 0.5 m from participant)	100	100
Door – open away	83	100
Door – open towards	83	100
2 cm obstacle	100	100
13 cm obstacle	0	16
Figure 8	83	100
Cross slope (L&R)	100	100
Incline ascent/descent (3.5°)	100	100
Pothole (15 cm)	83	100
Pothole (30 cm)	50	83
Level change ascent (5 cm)	83	83
Level change descent (5 cm)	83	83
Level change ascent (10 cm)	16	33
Level change descent (10 cm)	33	83
Wheelie, stationary	16	33
Wheelie, rolling forward 5 m	16	33
Wheelie, rolling backward 5 m	16	16
Wheelie, turn in place (L&R)	16	33
Wheelie, moving turn forward (L&R)	16	33
Wheelie, moving turn backward (L&R)	16	16
Wheelie, no-hands-rest	16	50
Wheelie, incline descent (7.5°)	16	16
Wheelie, 10 cm level change descent	0	33
Quick stop	5.5s/1 m	1.7s/.88 m
Right wheelchair after backward tip and get back into wheelchair	50	67

WST, Wheelchair Skills Test.

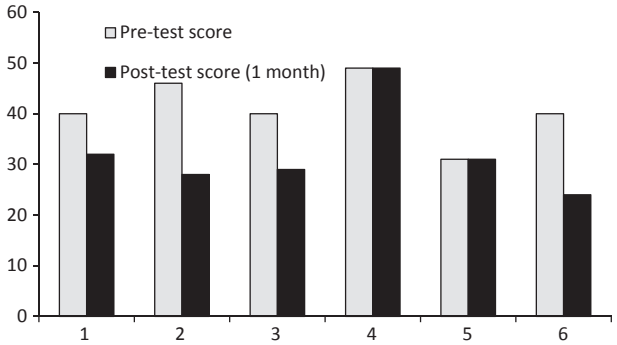

FIGURE 2: *Individual ASK Scores pre- and post-training.*

includes the stages of skill acquisition, skill retention and skill transfer (Magill, 2007). In this study, as there was really no retention period between the end of training and the final skills testing, the WST scores reflect skill acquisition, only. However, it could be argued that there was some retention period (1 week) for the skills taught on day one. The Impact Questionnaire reflected longer range impacts.

The improvement in wheelchair skills after training for this group of children was consistent with, but modest in comparison to the wheelchair skills training literature involving adults (Best *et al*., 2005; Coolen *et al*., 2004; MacPhee *et al*., 2004). Our group showed a 14% improvement compared to 20–25% improvements described in the adult literature (Best *et al*.). Additionally, it is important to look at the items that were improved for the children. Opening doors correctly, negotiating potholes, ascending and descending levels, turning and wheelies are all advanced level skills, which are extremely important in negotiating community environments. They may not be as important when traversing familiar environments that are fully adapted – such as home or school. However, as children move into new activities or environments, they become increasingly important over time and with age.

A number of other factors may explain differences between adult and children's responses to the wheelchair training skills programmes, and the modest improvements from the children. Firstly, the modification of the WST may have had a greater affect on outcome comparison to previous studies than expected. Secondly, the baseline range of skills was quite large making an average improvement modest for the small sample size. One improved 33% whereas another only 7%.

Some children had never received training, others had watched a skills training video, whereas one child had more formal experience of skills training in sports camps. The children with higher skills did not have the same room for improvement. For example, although quite young, one girl had been attending sports camps for several years and had mastered many skills prior to the camp, including wheelie related skills. She had modest improvement (90% pre to 100% post, a 10% improvement) but had the highest overall score.

The oldest participant showed the greatest improvement in skills (33%) which were more comparable to

adult literature results. It is possible she was ready to take advantage of the opportunity to improve upon her wheelchair skills in an effort to become more independent in her late adolescence. This is important when considering the provision, impact and timing of the programmes, but again, may reflect the participants' readiness to learn. The oldest participant was starting to experience environments more challenging to her mobility level, and thus she could see a direct result of this. In addition to being more socially and psychologically prepared to learn, as a young adult, she is stronger and her wheelchair weight to body weight ratio would be less. Many of the skills the participants could not master were the ascents on kerbs and ramps. These require not only skill but considerable strength as well. With many paediatric wheelchairs being relatively heavy or even heavier than many children, this makes these types of skills more challenging to do for this population. Introducing these skills is important early on but these more advanced skills need to be addressed again in later adolescence or early adulthood when the children are more physically developed.

Finally, the modest success in our study may be due to the intensive two-day camp style of training. The literature suggests that condensed training is less effective. More frequent, shorter training sessions, spread out over a longer period permit rest and allow for consolidation of what has been learned, are likely to be more effective (Magill, 2007). In fact, at various times throughout the two-day programme, some of the children exhibited signs of fatigue and frustration which may have been partially the result of the condensed training. Although perhaps not the ideal way of learning, results of this study indicate that a two-day WSTP does in fact improve wheelchair skill acquisition.

The ASK was used to see whether the acquisition of wheelchair skills transferred to the children's ability to perform more daily functional activities at home and in the community. Although the WST scores indicated that the children in this study have gained new skills, the ASK scores did not demonstrate an impact on participation in the lives of the children at home and in the community. This was a disappointing result.

The Impact Questionnaire, sent to participants four months post-training, indicated that the programme had a positive effect on the children's participation in their chosen activities. This was developed after the training sessions occurred to gain more qualitative value to what we did. Little did we know at the time, the ASK would be less useful. We believed the Impact Questionnaire was more representative than the ASK of the impact of the wheelchair skills learned during the programme on daily life. For example, the oldest participant showed significant improvements in independence as stated by her mum, 'she took the bus on her own to the shops and went for a coffee by herself to Starbucks for the very first time!'.

Children with disabilities may demonstrate passive-dependency behaviours relying on their parents to a greater extent than necessary. Often participation is just easier if mum or dad 'does it' (i.e. pushes them). It is possible that more than one month was required to change dependent behaviours and for the children to start using acquired skills for participating in daily activities. For example, the young lady who went to Starbucks didn't do this until a few months had passed.

The ASK provided this study with additional unexpected challenges, as children may, at times, have unrealistic insight into their capabilities. For example, participant #6's (spinal cord injury) perceptions of his own capabilities on the pre-training ASK were not at all reflective of his actual abilities and this led to a large decrease for his post-test ASK score due to more realistic responses.

Another unexpected challenge was that the ASK appeared to reflect some seasonal variation. The ASK questions whether the child performed a specific task 'within the last week'. We did the pre-training ASK in mid-November (early winter) and then the post-training ASK one month later which coincided with Christmas holidays when some of the participants may have had limited recreational participation with friends or peers due to the snow (the province's snowiest Christmas on record). Thus, many of the children were less active with their wheelchairs during this time. The ASK may not be as robust in dealing with these seasonal variations as initially hoped.

There are also a number of factors that may be at play in this sense. Although the ASK has been shown to be a valid and reliable tool in a number of studies, it was not able to show more individualised and goal driven results. It is useful to have an objective measure of participation, however, participation is notoriously difficult to measure (McConachie *et al*., 2006) and the challenge is to ensure that the tool used will address the issues raised. Other tools such as the LIFE-H (Assessment of Life Habits), CHQ [Child Health Questionnaire, and the PedsQL (Paediatric Quality of Life)] are designed more to judge quality of life, however, it is difficult to see how they would address participation any better than the ASK, which is designed to address the affect of physical skills on participation. The individually designed Impact Questionnaire showed much more positive, although less rigorous results. The Children's Assessment of Participation and Enjoyment (CAPE) and the Preferences for Activities of Children (PAC) CAPE/PAC are matched assessments which explore children's day-to-day participation in activities (CAPE), or preference for activities (PAC) (King *et al*., 2004). However, they do not address the specific issues of meaningful participation for the child and their families.

In future studies, we suggest that the ASK continue to be used. However, the Canadian Occupational Performance Measure (COPM) would be a useful adjunct

(Cusick, Lannin & Lowe, 2007). The COPM is person centred, and is able to assess the children's occupational performance but also their satisfaction, and has been used successfully with children. The limitations of the COPM with children include possible unrealistic expectations when goal setting, or the child not always being the best judge of their own progress. However, these limitations will be alleviated somewhat by the continued use of a more objective measure, and having parents act as proxies for younger children or those with cognitive impairment.

Finally, the method of programme delivery must be addressed. The two-day skills programme was resource friendly, but not necessarily the most developmentally appropriate method. We would like to see a staged programme, which gives children a 'boost' over several periods of time, when they are developmentally and chronologically ready to understand the implications of their skill acquisition on their participation. It may be suggested that if the WSP is used for children the skills are presented as suggested in Best *et al.* (2005) with indoor skills, community skills and advanced skills and these would be presented at the various stages of a child's development instead of presenting them all at one training programme. This is now currently being implemented in clinical practice and evaluated at a rehab centre in Australia using the WST 4.1 using a larger sample size. Hopefully this will tell us more definitively the impact a wheelchair skills programme has for children.

Conclusions

This study shows that we can potentially improve wheelchair skill acquisition among children with intensive training in the format of a two-day skills programme using a modified WST 3.2. This information is valuable in a day where no standard wheelchair skills training is provided to children and logistical constraints make it difficult to provide training in a short, frequent session.

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