Research article

Short-term influence of transfer training among full time pediatric wheelchair users: A randomized trial

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Objective/Background: To describe a structured, short-term, transfer training intervention for full-time pediatric wheelchair users, investigate the impact of training on transfer skills, and to examine similarities and differences in response to training compared to those seen in adult wheelchair users.
Design: Randomized clinical trial.
Methods: Participants were first randomized into an intervention (IG) or control group (CG). After completing surveys and demographic intake forms, all participants performed two sets of level transfers (from wheelchair to bench and back to wheelchair = one set) at three time points. Each time point composed of two transfer sets were scored using the Transfer Assessment Instrument (TAI) and averaged to produce a final transfer score per time point. No feedback or training were given to participants prior to time points one and two however the IG received structured training prior to transfer assessment # 3. TAI scores were compared at transfer assessment #3 using a Mann-Whitney test.
Outcome measures: Transfer Assessment Instrument (TAI) and Self-Perception Profile for Children (SPPC).
Results: Intervention group participants demonstrated significant improvements among TAI scores (9.06 ± 1.01) compared to the control group (7.15 ± 1.67), $P = 0.030$, $d = 1.385$. No significant differences were found among SPPC scores.
Conclusion: Pediatric wheelchair users transfer skills were found to improve immediately after training with TAI score changes similar to those seen in adult wheelchair users after training. Such improvements may be a factor in long-term upper extremity preservation. Further testing is needed to examine the long-term impact of improved transfer skills.

Keywords: Wheelchair, Disabled children/rehabilitation, Young adult, Activities of daily living

Introduction

The ability to effectively transfer is an important skill for full time mobility device users in daily life.[1] Transfers, defined as movement to/from a wheelchair to a goal surface, such as getting out bed or transferring to a shower chair or car seat, are needed to perform essential activities of daily living, actively participate in the community, and achieve high levels of quality of life. In a survey of full time wheelchair users, 4 of the 10 wheelchair skills deemed to be most important were related to transfers.[2] Maintenance of transfer skills across the lifespan has also been found to be associated with increased life expectancy.[1] Due to their essential nature, transfers are performed frequently throughout the day. A typical manual wheelchair user will perform 14–18 transfers on a daily basis.[3]

Among adult wheelchair users, transfers are a frequent cause of upper extremity pain[4] and often described as one of the most demanding wheelchair related activities.[5] During daily transfers, the upper limbs are exposed to high forces and moments repeatedly. The shoulder joint however is designed for mobility, not stability and these increased demands may predispose individuals to injury.[6] Thus, high levels of repetitive force often lead to structural degeneration and pain.[6]

Between 31–73% of adults report shoulder pain[3,7,8] of which 92% hypothesized that the pain originated from

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transfer activities and wheelchair propulsion.[9] Long term wheelchair users reported that the highest levels of pain occurred when transferring to non-level surfaces, along with ascending a ramp, performing overhead reaching and washing their back.[4] Upper extremity pain can also significantly limit independence,[10] quality of life and the ability to participate in the community.[6,11] Among individuals with spinal cord injury, 26% of survey respondents stated they needed additional assistance with activities of daily living and 28% reported independence limitations associated with upper extremity pain.[12]

As a result of frequent performance of necessary tasks that are largely unavoidable and the negative impact on the health of the upper extremity, understanding the correct way to perform a transfer is important to the long-term health and wellbeing of a wheelchair user.[13] Unfortunately, pediatric wheelchair users often do not receive wheelchair skills training, including instruction on transfer skills. Such training however, is a much-needed intervention in order to teach good habits at an early age and prevent the development of upper extremity injuries and impairments in both the short and long term.

In the short term, transfer training gives pediatric wheelchair users the ability to move about within their environment independently and explore. Independent exploration can foster growth and development[14,15] and enhance participation with peers. Thus, acquisition of transfer skills is needed for appropriate psychosocial development.

Because pediatric wheelchair users often do not receive formal transfer training,[16] they often have to "figure it out" on their own. Acquisition of such an important skill through a trial and error method however, is likely to have a detrimental impact. Previous research has shown that utilizing optimal techniques during a transfer can significantly decrease the magnitude of force placed on the upper extremity[13] and help preserve upper limb function over the long term.

The purpose of this paper is multi-factorial. We will first describe a structured transfer-training intervention intended to educate pediatric wheelchair users on best practices associated with transfers, based on previous research findings.[13,17–19] Second, the study aims to examine the preliminary feasibility of the structured transfer-training intervention to improve short-term transfer skills and self-perception among pediatric wheelchair users. Finally, we will examine if pediatric wheelchair users respond to training in a similar manner as adults and if they can benefit from the same training techniques. We hypothesize that short-term exposure to a structured training intervention would lead to concomitant improvements in transfer skills and self-perception with results similar to that of adults.

Methods

A randomized clinical trial was conducted on the campus of the University of Illinois at Urbana-Champaign (UIUC) during a Wheelchair Basketball skills camp in July 2014. The research presented in the current study on transfer training is part of a larger study examining both transfer and wheelchair propulsion training of pediatric wheelchair users. Data on wheelchair propulsion training is presented elsewhere[20] and only data on the transfer training aspect of the protocol will be presented in this paper. UIUC's institutional review board approved all study related procedures. Informed consent was obtained from all participants, along with ascent from the parents/guardians of the study participants.

Individuals were invited to participate in the study if they met the following inclusion criteria requirements: (1) 8–18 years old; (2) self-report independent use of a manual wheelchair as their primary means of mobility; (3) at least 2 years post onset of disability requiring wheelchair use; (4) free of any traumatic upper extremity injury or disability that would be exacerbated by physical activity.

A convenience sample of 14 study participants were recruited through a study advertisement posted on UIUC's website, in addition to face-to-face recruitment during event registration.

Study design

After completion of informed consent/parental ascent, participants were randomized with a 1:1 randomization scheme into an intervention (IG) and control group (CG) by an investigator not involved with the assessment. A total of seven (7) participants were randomized to the IG and seven (7) to the CG (Fig. 1). Two CG participants dropped out prior to data collection citing they were no longer interested in participating, leaving a total of five (5) CG members.

Participants were asked to complete a basic survey to gather demographics and information related to their disability. Participants were also asked to complete the Self-Perception Profile for Children (SPPC).[21] The SPPC is a 36-item well-established, reliable and validated tool[22] used to assess a variety of factors associated with self-perception in pediatric populations. The tool has been validated for use with children as young as 8 years old.[22] Based on the objectives of the study, we

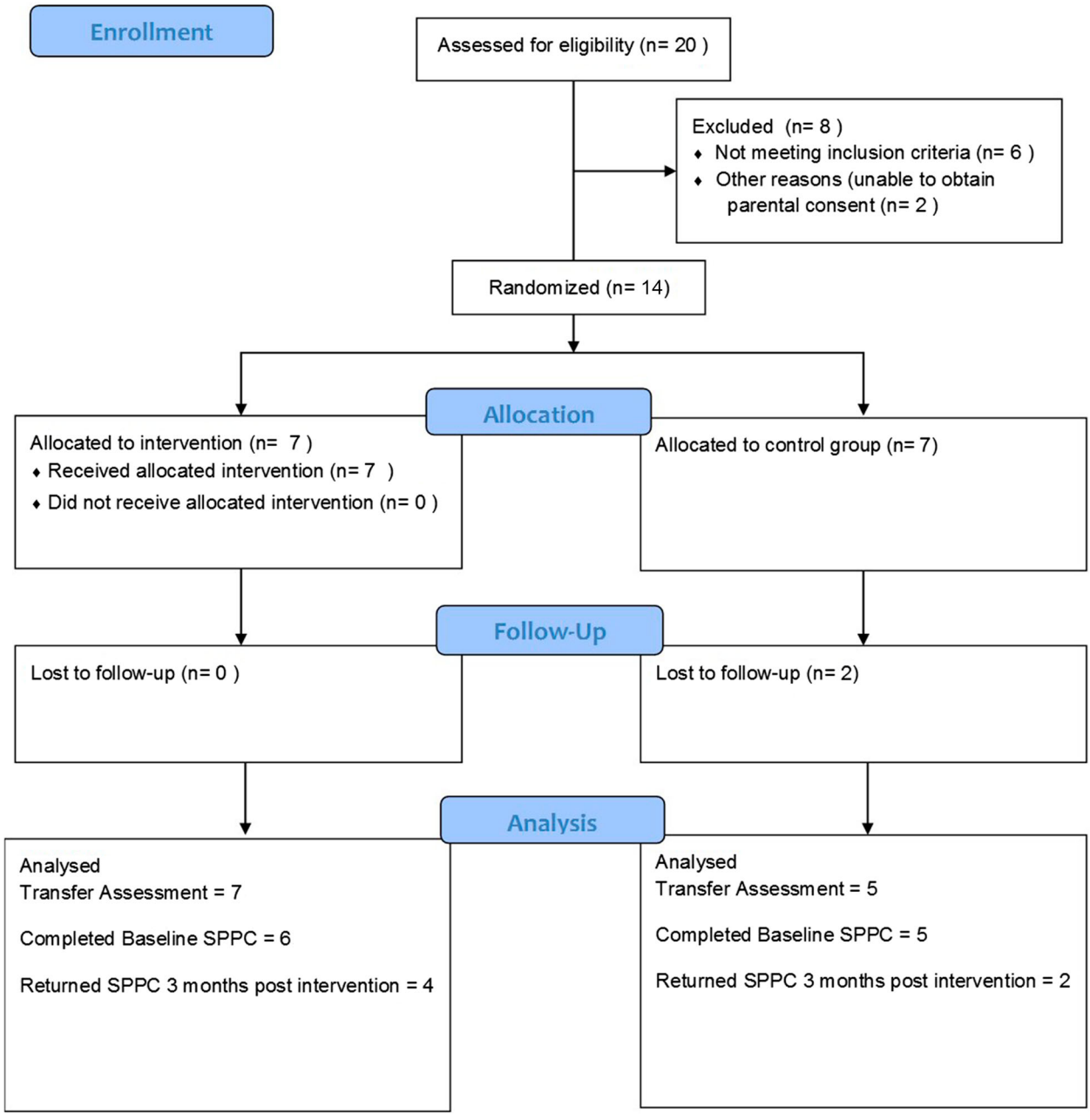

Figure 1 CONSORT flow diagram.

have focused on the social competence and global-self-worth subscales. The social competence subscale evaluates attributes of the person that determine social success. The global self-worth evaluates general perceptions of self, similar to self-esteem.[23] After receiving initial instructions, participants completed the SPPC independently. Participants were also mailed a copy of the SPPC with written instructions describing how to complete the survey 3 months after the initial study visit and asked to return via a self-addressed envelope.

Study Protocol	
Randomization	
IG (7)	CG (5)
Transfer Assessment #1 (all)	
10 Minute Rest (all)	
Transfer Assessment #2 (all)	
Transfer Education Intervention (IG only)	20 minute rest (CG only)
Transfer Assessment #3 (all)	
IG = Intervention Group, CG = Control Group	

Figure 2 Study protocol.

All participants were then asked to perform two sets of level transfers (from wheelchair to a padded bench and back to wheelchair = one set) at three time points for a total of six transfer sets (Fig. 2). The padded

bench has a rectangular surface measuring 64 cm by 57 cm, with a height of 51 cm. The average wheelchair seat to floor height of the participant's wheelchair was 53.42 (SD = 2.48) cm. Thus, all participants performed a relatively level transfer because the bench compressed slightly under the load of a transfer. Participants had adequate space to freely position their wheelchair based on their preferences. After completion of baseline testing (Time point #1/Transfer Assessment #1), all participants were given a 10 minute rest and then asked to perform two more sets of the same transfers (Time point # 2/Transfer Assessment #2) to assure they were adequately accommodated to transferring to the target surface. No feedback or training was given to participants prior to or during the first two assessments. After completion of Transfer Assessment #2, participants randomized to the IG received a structured training session on preferred transfer techniques, as described below in the "transfer intervention" section. Participants in the CG were given a 20-minute rest break. After the IG completed their transfer education intervention and the CG finished their rest period, both groups completed two more sets of transfers (Time point # 3/Transfer Assessment #3).

Transfer quality was assessed using the Transfer Assessment Instrument (TAI)[24] at each of the three time points. Each time point, composed of two transfer sets, were scored independently and averaged to produce a final transfer score per time point. The TAI is designed to evaluate the quality of a transfer and the consistency of performance. The instrument has been found to be reliable and valid among adult full time wheelchair users[25] living with a variety of neurological impairments. Individual components of a transfer are evaluated; such as the hand placement of the participant or the distance their wheelchair is from the target surface. In addition, overall conservation of movement, safety and quality is evaluated. Participants receive a final score between 0–10 in which 0 indicates poor quality and 10 indicates high quality.[25] Previously research has used the TAI to examine the impact of transfer education among full time adult wheelchair users. Results indicate that the measure is sensitive to change after transfer education is provided.[26]

Transfer intervention

Participants randomized to the IG received education on proper transfer techniques prior to time point 3/assessment 3. After receiving instructions on the purpose of the educational session, participants were shown a 9-minute video describing the important components associated with transfers including proper upper extremity placement, body positioning, conservation techniques, movement strategies and hand placement. A multi-disciplinary team of researchers, clinicians and wheelchair users developed the video. Although not specifically targeted to children, the video used very basic language and descriptions in order to accommodate a large variety of individuals.[27] To enhance learning, the video breaks transfers down into three phases: set up (Fig. 3), flight (Fig. 4) and landing (Fig. 5). Participants received instruction on

Figure 3 Transfer set-up phase.

Figure 4 Transfer flight phase.

Figure 5 Transfer landing phase.

each individual phase and then the entire transfer strategy was reviewed together. The information presented within the video was based on peer-reviewed research presented in the Clinical Practice Guidelines for Preservation of Upper Limb Function Following Spinal Cord Injury[28] and other relevant transfer research.[13,17,18,29–32] After watching the video, participants were given the opportunity to ask specific questions about the content of the video and transfer technique. Participants were also given the opportunity to practice the newly learned skills and receive feedback on performance. Feedback was provided by a physical therapist with over 10 years of experience providing education to wheelchair users. The training intervention was well tolerated and participants were able to return to their normal daily activities immediately after participation.

Statistical analysis

Statistical analysis was performed using SPSS version 22 (IBM Corp, Armonk, NY, USA). Due to the small sample size and ordinal nature of the data, non-parametric statistics were used. TAI scores were compared at each time point (Transfer Assessment 1–3) using Mann-Whitney tests. SPCC scores were compared at the baseline assessment and 3 months post baseline testing using Mann-Whitney tests. Additional testing was performed to examine the correlation between age and years of wheelchair use on pre-intervention transfer performance (Transfer Assessment #2). Non-parametric Spearman's ρ correlations were used to examine potential associations due to the ordinal nature of the transfer data. Sample size was small making the finding of statistical significance difficult therefore emphasis was placed on calculating effect sizes per outcome measure as suggested by Rutledge and Loh.[33] Even small effect sizes can have important clinical implications and are therefore important to report.[33] Effect size (d) associated with the intervention were calculated using Cohen's *d* (difference in mean scores over time divided by pooled SD) and were interpreted as small ($d \leq 0.2$), moderate ($d \sim 0.5$), and large ($d \geq 0.8$).[34] Significance was set *a priori* at $P = 0.05$. No corrections were made for multiple comparisons due to the pilot nature of the research and small sample size.

Results

Demographics

In July 2014, 12 pediatric wheelchair users participated in a randomized trial to examine the impact of structured training on transfer skills and self-perception. Participants were an average age of 15.69 (SD ± 1.44) years ranging between 13–18 years old, with 10.77 (SD ± 3.83) years of wheelchair use. The most common type of disability represented was Spina Bifida impacting 41.7% of participants. Demographic information presented in Table 1. No significant differences existed among study groups based on demographics.

Transfer performance

TAI scores at each time point are presented in Table 2. No significant differences on TAI scores existed between study groups at Transfer Assessment #1 ($P = 0.755$) or Transfer Assessment #2 ($P = 0.876$). In addition, no significant within-subject differences were found in the IG ($P = 0.063$) or the CG ($P = 0.279$) between Transfer Assessment #1 and #2.

Mann-Whitney tests were performed to examine differences in transfer performance after exposure to an educational program. Results indicate that after exposure to the intervention, participants in the IG (mean = 9.06, SD = 1.01) had significantly higher scores compared to the CG (mean = 7.15, SD = 7.15), $P = 0.030$, $d = 1.385$.

Social competence and global self-worth

Social competence and global self-worth scores are presented in Table 3. Only 6 participants (IG = 4, CG = 2) returned the SPPC 3 months after the initial study visit. A Mann-Whitney test was performed to examine social competence and global self-worth subscores of the SPPC scores 3 months post exposure to the intervention. No significant differences were found in social competence based on exposure to the education program over time, IG (mean =17.50, SD = 3.11), CG (mean = 18.00, SD = 0.00), $P = 1.00$, $d = 0.227$. In addition, no significant differences were found in

Table 1 Demographic information

Variable	All Participants	IG (n = 7)	CG (n = 5)	P-value	
Age m (SD)		15.69 (1.44)	15.43 (1.72)	15.80 (1.10)	0.681
Years Using a Wheelchair m(SD)		10.77 (3.83)	9.43 (4.16)	11.80 (3.03)	0.305
Sex n (%)	Male	8 (66.7)	4 (57.1)	4 (80.0)	0.550
	Female	4 (33.3)	3 (42.9)	1 (20.0)	
Disability Type n (%)	Amputation	2 (15.4)	1 (14.3)	1 (20.0)	0.882
	Cerebral Palsy	1 (7.7)	0 (0.0)	1 (20.0)	
	Spinal Cord Injury	3 (23.1)	2 (28.6)	1 (20.0)	
	Charcot-Marie-Tooth	1 (7.7)	1 (14.3)	0 (0.0)	
	Spina Bifida	5 (41.7)	3 (42.9)	2 (40.0)	

Table 2 Transfer Assessment Instrument (TAI) scores

Time Point m (SD)	All Participants (n = 12)	IG (n= 7)	CG (n = 5)	P-value	Cohen's *d*
Transfer Assessment #1 (Base-line)	6.94 (1.60)	6.90 (1.66)	7.00 (1.81)	0.755	0.056
Transfer Assessment #2	7.37 (1.64)	7.43 (1.54)	7.29 (1.56)	0.876	0.090
Transfer Assessment #3 (Post IG intervention)	8.26 (1.60)	9.06 (1.01)	7.15 (1.68)	**0.030***	1.385

*= $P < 0.05$

global self-worth IG (mean = 19.25, SD = 4.86), CG (mean = 19.50, SD = 2.12), P = 1.00, d = 0.066. Changes in IG scores pre and post intervention were also examined and no significant differences were found among social competence (P = 0.655) and self-worth (P = 0.655).

Factors influencing transfer skills

Correlational analysis was performed to examine the impact of variables previously associated with enhanced wheelchair skills[35] including age and years of wheelchair use. There were no significant correlations found between age (r_s = 0.462, P = 0.130) or years of wheelchair use (r_s = –0.383, P = 0.219).

Adult vs. pediatric response to training

In a previous study by Rice, *et al.*[26] adult participants showed a 3.17% change in TAI score after exposure to a transfer intervention: Pre- Intervention: m = 8.82, SD = 1.12 and Post-Intervention: m = 9.08, SD = 1.61. Pediatric wheelchair users showed a 22.48% change in TAI scores Pre-Intervention: 7.43, SD = 1.54, Post- Intervention: 9.06, SD = 1.01.

Discussion

The purpose of this paper was to describe a basic but structured education program designed to educate pediatric wheelchair users on transfer skills, examine the preliminary feasibility of the program and determine if pediatric wheelchair users respond to training in the same way that adults do. Results indicate that the training program was well-tolerated by participants despite the repetitive process. After exposure to the program, transfer performance improved significantly, however there were no changes in self-perception related variables three months later. Because participants were also educated on wheelchair propulsion skills, it is unclear if the lack of self-perception results were related to transfer or propulsion training or a combination of the two. Results also indicate that pediatric wheelchair users respond to training in a similar manner as adults and demonstrated a greater change in TAI scores compared to adults.

Transfer-training

Limited research has specifically focused on transfer training of pediatric wheelchair users. Sawatzky *et al.*[16]

Table 3 Self-perception profile for children

Time Point n/mean/SD	All Participants	IG	CG	P-value	Cohen's *d*
Social Competence Sub-score					
Baseline testing	11/18.36/3.91	6/16.50/3.02	5/20.60/3.91	0.082	1.173
3 Months Post Baseline	6/17.67/2.42	4/17.50/3.11	2/18.00/0.00	1.000	0.227
Global Self-Worth Sub-score					
Baseline testing	12/20.25/3.70	7/21.57/2.70	5/18.40/4.39	0.149	0.870
3 Months Post Baseline	6/19.33/3.88	4/19.25/4.86	2/19.50/2.12	1.000	0.066

examined the impact of a general wheelchair skills training program that included transfer skills. Consistent with our findings, Sawatzky *et al.* found that after exposure to training, wheelchair skills improved significantly in the short term. To the best of our knowledge, our program is the first to specifically provide transfer technique training to pediatric wheelchair users. Although our sample size was small, the large effect size found ($d = 1.38$) indicates that the differences found are noteworthy. Due to anticipated life-long wheelchair use, such improvements in quality are significant as upper extremity impairments associated with repetitive strain may be particularly detrimental to a pediatric population as a result of long-term exposure.[36] In addition, due to the repetitive nature of the task, even small adjustments may make a significant impact in long-term upper extremity preservation over time and set pediatric wheelchair users on a healthier trajectory for life. The development and critical evaluation of a training protocol is necessary as the majority of pediatric wheelchair users receive little or no transfer training. In fact, correlational analysis revealed that even long term experienced users showed room for improvement. Thus, simple repetition over time did not guarantee use of proper technique and being a long-term wheelchair user was not associated with transfer quality.

An evidenced-based training program is an essential tool that would provide clinicians a much-needed foundation on which they can base therapeutic interventions. This program may also be able to serve as a foundation on which more complex functional transfers, including those to a car seat, tub bench or toilet seat can be based. The structure of the program also has the potential to be used independently by pediatric wheelchair users and their families.

Results found in the current study are consistent with findings among adult full time wheelchair users recently discharged from acute rehabilitation.[26] After receiving structured transfer training based on the Clinical Practice Guidelines for Preservation of Upper Limb Function Following Spinal Cord Injury[28] and recent research findings,[12,21–26] participants who performed assisted and dependent transfers showed significant improvements in transfer quality, as measured by the TAI.[26] Trends in the data also found that participants who performed independent transfer had higher quality transfers after exposure to the intervention.

Self-perception

No significant differences in social competence or global self-worth, as measured by the SPPC, were found between study groups or pre and post exposure to the intervention. Our analysis was limited due to the low response rate (n = 6) and short follow up time. A longer follow up period may be necessary to see changes among psychosocial variables. Despite the lack of findings, concepts related to self-perception are important among pediatric wheelchair users and further testing should be performed to fully examine the impact of improved functional mobility on self-perception and other critical psychosocial indicators. Previous research indicates that among infants and very young children with mobility limitations, achieving adequate functional mobility is essential for the development of social interactions, self-awareness, confidence and socialization.[37] Among adult wheelchair users, high levels of self-esteem and self-efficacy have been found to be related to psychological well-being,[38,39] greater life satisfaction,[38–41] lower depression[42] and critical to high levels of quality of life.[43] Limited research has examined a similar concept in a pediatric wheelchair user population.

Study limitations

There are several limitations to consider with the study. First, the sample size of our study was small (n = 12) and had a homogeneous age range (m = 15.58 years, SD = 1.44 years), therefore results may not be generalizable to a larger group of pediatric wheelchair users. It is unclear to what extent younger manual wheelchair users would respond similarly to the training program. Although small and homogeneous, no other studies have investigated the impact of transfer training among pediatric wheelchair users. In addition, the lack of influence of age and years of wheelchair use indicates that the transfer training program had a substantial independent impact on TAI outcomes and that active and experienced users can still benefit from the training program. These results provide important preliminary data. In future studies we plan to increase the sample size and enroll more diverse participants to improve the generalizability of the study. In addition, a larger sample size will allow us to perform a more detailed analysis of the TAI results to determine which individual components of the TAI most influence overall quality and are most amenable to training. This could lead to a more customized approach to training based on an individual's unique needs. In addition, limited follow-up time was available to examine the long-term impact of the training protocol. The extent to which technique changes will persist in the long term is unknown. Future studies are planned to examine the same participants one year after receiving the intervention to

determine if the program continues to have a significant impact on IG participants. Also, the investigator performing the transfer assessment was aware of group assignment and may have been biased when performing Transfer Assessment #3. The investigator however is an experienced research clinician familiar with performing objective evaluations in a variety of clinical and research settings. Future work includes plans to blind the evaluator performing the assessments to study group placement. Also, as a result of differences in wheelchair cushion height, some participants may have performed more of an uneven transfer compared to others. In addition, the TAI has not been validated among pediatric wheelchair users. There are however no validated outcome measures appropriate to objectively evaluate pediatric wheelchair users. The TAI evaluates generic transfer activities appropriate for both adult and pediatric users, thus making it a reasonable tool to use. Finally, a limited number of participants completed the SPPC 3 months after completion of the study, thus limiting our ability to fully investigate the influence of transfer technique on self-perception.

Conclusion

This randomized clinical trial is among the first to examine the short-term impact of a structured, evidenced-based transfer-training program among pediatric wheelchair users. Results indicate that after exposure to transfer training, transfer quality significantly improved. Our findings were also consistent with those found in adults, indicating that similar strategies may be effective in training both pediatric and adult wheelchair users. No significant differences were found among self-perception. This preliminary work will serve as important basis in the development of evidenced-based transfer training programs that can be used both clinically and independently by pediatric wheelchair users.

Disclaimer statements

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Conflicts of interest None.

Ethics approval None.

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