ORIGINAL ARTICLE

Wheelchair Skills Training for Community-Based Manual Wheelchair Users: A Randomized Controlled Trial

Krista L. Best, MSc, R. Lee Kirby, MD, FRCPC, Cher Smith, BSc OT, Donald A. MacLeod, MSc

ABSTRACT. Best KL, Kirby RL, Smith C, MacLeod DA. Wheelchair skills training for community-based manual wheelchair users: a randomized controlled trial. Arch Phys Med Rehabil 2005;86:2316-23.

Objective: To test the hypotheses that wheelchair skills training of community-based manual wheelchair users is efficacious, safe, and practical.

Design: Randomized controlled trial.

Setting: Rehabilitation center and community.

Participants: Twenty community-based manual wheelchair users (15 men, 5 women; age range, 21–77y), half with musculoskeletal and half with neurologic disorders.

Intervention: Participants were randomly allocated to the Wheelchair Skills Training Program (WSTP) or control groups. In 1-hour individualized sessions, the WSTP group participants received a mean ± standard deviation of 4.5±0.7 hours of training. Caregivers participated whenever possible. In addition to training at the rehabilitation center, the trainer traveled to administer training in the community.

Main Outcome Measures: Using the Wheelchair Skills Test (WST, version 3.1), an objective test of 57 skills, we calculated total and subtotal percentage scores (percentage number of skills passed of those possible) and individual skill success rates.

Results: The WSTP group's improvement in total WST score was significantly greater than the control group's ($P<.005$). The mean total WST score for the WSTP group increased from a pretraining value of 63.3%±6.0% to 78.5%±8.3% posttraining, a relative improvement of 24.0% ($P=.002$). The control group increased from a baseline value of 70.8%±14.0% to 74.2%±11.8% at follow-up, a relative improvement of 4.8% ($P=.03$). The WSTP group had clinically significant pre- and posttraining improvements (≥20%) in the success rates of 25 of the 57 individual WST skills, compared with only 5 skills for the control group. There were no adverse incidents, and the WSTP participants' comments were all positive.

Conclusions: Wheelchair skills training of community-based manual wheelchair users is efficacious, safe, and practical. These findings have implications for the standard of rehabilitation care.

From the School of Health and Human Performance (Best) and Division of Physical Medicine and Rehabilitation, Department of Medicine (Kirby), Dalhousie University, Halifax, NS; and Department of Occupational Therapy (Smith) and Clinical Locomotor Function Laboratory (MacLeod), Queen Elizabeth II Health Sciences Centre, Rehabilitation Centre Site, Halifax, NS, Canada.

Presented to the Rehabilitation Engineering and Assistive Technology Society of North America, June 26, 2005, Atlanta, GA.

Supported by the Nova Scotia Health Research Foundation (grant no. PSO-SRA-2003-664) and the Canadian Institutes of Health Research (grant no. 43661).

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit upon the author(s) or upon any organization with which the author(s) is/are associated.

Correspondence to R. Lee Kirby, MD, FRCPC, Queen Elizabeth II Health Sciences Centre, Rehabilitation Centre Site, 1341 Summer St, Halifax, NS B3H 4K4, Canada, e-mail: *kirby@dal.ca.* Reprints are not available from the author.

0003-9993/05/8612-9829$30.00/0

doi:10.1016/j.apmr.2005.07.300

Key Words: Caregivers; Motor skills; Rehabilitation; Wheelchairs.

THE WHEELCHAIR IS AMONG the most important of rehabilitation interventions. Wheelchair users, however, face many mobility and participation barriers[1,2] and are at risk for acute and chronic injuries.[3-6] To address these problems, efforts have been made to improve accessibility, wheelchair design, and the wheelchair-delivery process. Increasingly, attention is being paid to wheelchair skills training[7-11] as an important component of these efforts.

The Wheelchair Skills Training Program (WSTP)[12] was developed as a means of formalizing such training. The WSTP includes a pretraining assessment (the Wheelchair Skills Test [WST]),[13,14] followed by training sessions (based on the extensive literature on motor-skills training and wheelchair skills), and then a posttraining assessment. The WSTP has been found to be efficacious, safe, and practical in the 3 trials in which it has been evaluated, with occupational therapy students,[7] caregivers,[9] and wheelchair users admitted for initial rehabilitation[8] in these studies as the trainees.

In the latter study, MacPhee et al[8] studied 35 manual wheelchair users during their periods of initial rehabilitation. Those who were randomly allocated to the WSTP group each received an average of 2.25 hours of training. There were no adverse incidents. The WSTP group had a significantly greater improvement ($P<.001$). The WSTP group's mean total WST percentage score improved by 25% ($P<.001$), whereas the control group, in which no additional training was received, improved by 8% ($P=.01$).

Although the MacPhee[8] study suggests that wheelchair skills training can lead to improvements in wheelchair skills during initial rehabilitation, this is a busy and relatively brief period for new wheelchair users. Wheelchair skills training must compete with other priorities, such as investigations, bladder and bowel care, conditioning, equipment selection, counseling, and organizing architectural modifications. Consequently, the new wheelchair user may reenter the community with suboptimal wheelchair skills. Continuing such training after community reentry seems like a sensible strategy because there should be fewer time constraints to interfere with training and, after experiencing a wider range of architectural barriers, wheelchair users may better recognize the need for such training.

The primary purpose of this study was to test the hypotheses that wheelchair skills training of community-based wheelchair users is efficacious, safe, and practical.

METHODS

Participants

We studied 20 community-based manual wheelchair users. The sample-size estimate was based on a power analysis. For this, we used variability data from the MacPhee[8] study (a mean ±

standard deviation [SD] pre- and posttraining difference of 16.0%±7.8% between the WSTP and control groups), what we defined as a clinically significant effect size of 20%, an α of .05, and a 2-sided 2-sample *t* test. This analysis suggested that a power of 90% would be possible with 10 participants per group.

From the participants and/or their health records, demographic and clinical data were collected (eg, age, sex, living arrangements, principal diagnoses). Wheelchair-related quality of life (QOL) measures were assessed at intake as a means of characterizing the participants with respect to their perceptions about wheelchairs and how these assistive devices affected their daily lives. The measures used were the Psychosocial Impact of Assistive Technology Devices Scale (PIADS)[15,16] and the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST), version 2.0.[17,18]

Recruitment and Screening

To recruit manual wheelchair users who lived in the community, we used posters, word of mouth, and clinicians on the outpatient and inpatient services. Eligibility to participate was based on the following criteria: participants were 17 years of age or older, were alert and cooperative, were coherent and competent to give informed consent, were able to answer questions related to wheelchair use (or had a proxy to do so), were willing to participate, were living in the community, used a manual wheelchair for a period of at least 6 weeks, used a wheelchair for at least 2 hours a day on average, self-propelled their wheelchairs, and had written permission from their family doctor or physiatrist to participate. Potential participants were excluded if they had any unstable medical conditions or emotional problems that may have made testing or training unsafe or unpleasant.

Ethical Issues

Participants who were recruited by poster or word of mouth contacted the primary research investigator. A care provider approached participants who were recruited from the rehabilitation center. Ethical approval for this study was obtained from the Research Ethics Board of the Capital District Health Authority. Before data collection, informed consent was obtained from each participant. Participants who came to the rehabilitation center for testing and training were compensated for parking fees.

Group Allocation

Participants were randomly allocated to WSTP or control groups by using a 2×2 table of random numbers. Diagnostic group (either musculoskeletal or neurologic) was used to stratify the participants for the purpose of having approximately equal representation in both groups.

Wheelchairs

Participants were asked about their history of wheelchair use, specifically the extent of their wheelchair usage (in months); their frequency of wheelchair use (in hours per day); and their methods of wheelchair propulsion (eg, 2 hands). We tested and trained participants in their own manual wheelchairs and recorded the wheelchair specifications.

Wheelchair Skills Test

Participants in both groups completed the WST, version 3.1, twice.[12] WST 1 was performed at intake. WST 2 took place at least 5 days after completion of training for the WSTP group to increase the likelihood that consolidation and retention had taken place[19,20] and after an approximately equivalent interval for the control group. To avoid tester bias, an experienced tester, other than the principal investigator, administered all WST evaluations. She was blind to group allocation, unless inadvertently informed by the participants. Four participants were unable to complete WST 2 at the rehabilitation center, so the questionnaire version of the WST (WST-Q)[12,21,22] was administered. For the purposes of this study, the WST and WST-Q results were considered equivalent, based on the excellent correlations between the total WST and WST-Q scores that have been reported.[21,22]

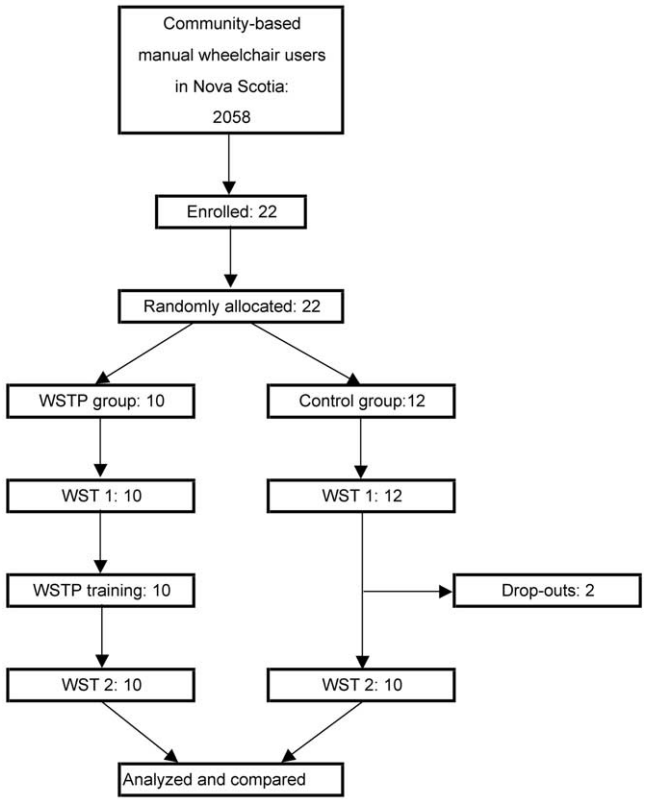

Fig 1. Flow diagram reflecting participant involvement in accordance with the CONSORT guidelines.[24] WSTs 1 and 2 refer to the initial and final WST. The numbers after the colons reflect the number of potential or actual participants.

Wheelchair Skills Training Program

Participants in the WSTP group received 3 to 5 one-hour WSTP, version 3.1,[12] training sessions from a single trainer (KLB) who had been thoroughly trained in WSTP training. Participants with higher skill level at baseline and those who were not interested in learning some of the more difficult skills required less training. The sessions were scheduled at least 5 days apart. At the beginning of each session, participants spent 5 to 10 minutes reviewing their progress and socializing with the trainer, followed by a 10-minute warm-up that consisted of random practice of the previously learned skills. For the next 20 to 30 minutes, participants attempted new skills. For each skill and for the series of training sessions, training continued until the skills were learned or until the trainer and participant mutually agreed that training should be abandoned. After moving on to the next skill, the trainer periodically asked the participant to practice newly learned skills. The final 15 to 20

Table 1: Participant Characteristics and Group Comparability

Characteristics	Parameter	WSTP	Control	*P*
Age (y)	Mean ± SD	49±16	48±23	.59
	Range	27–69	21–77	
Sex	Men	8	7	.71
	Women	2	3	
Diagnostic group	Musculoskeletal	4	6	.34
	Neurologic	6	4	
Specific diagnosis	Amputations	4	6	
	Stroke and acquired brain disorders	4	1	
	Spinal cord injuries	1	1	
	Peripheral neurologic disorders	1	2	
Living arrangement	Alone	1	2	.5
	Family/friends	6	7	
	Part-time caregiver	2	1	
	Full-time caregiver	1	0	
Wheelchair experience (mo)	Mean ± SD	11±151	34±66	.10
	Range	2–338	2–208	
Frequency of wheelchair use	<2h/d	2	0	.68
	2–5h/d	1	3	
	5–8h/d	2	2	
	>8h/d	5	5	
Method of wheelchair propulsion	2 hands	6	7	.76
	1 hand	0	0	
	1 hand and 1 foot	1	0	
	2 hands and 1 foot	3	3	
QUEST	Device (mean ± SD)	3.79±0.70	4.14±0.75	.32
PIADS	Competence (mean ± SD)	1.49±1.17	1.30±1.33	.74
	Adaptability (mean ± SD)	2.18±1.17	1.27±1.72	.14
	Self-esteem (mean ± SD)	1.28±1.05	0.99±1.12	.56

minutes of each session consisted of a warm-down, during which the participant practiced skills in a self-controlled environment.

When necessary, the trainer traveled to the participants' homes and their neighboring communities to conduct training. In such instances, the trainer documented any significant variations in the skill setting from that described in the Wheelchair Skills Program (WSP) manual.[12] The trainer recorded observations about the training sessions, participant comments, and the number of training sessions needed. After the final training session, each participant completed a brief posttraining questionnaire about his/her perceptions of the training.

Control Group

The trainer contacted the participants in the control group by telephone 3 times in the period between WST 1 and 2. As a further incentive to participation, training was offered to the control group on completion of the study procedures.

Safety

Precautions were taken, as prescribed in the WSP manual,[12] to avoid injuries during testing and training procedures. The trainer and tester used spotter straps[23] during any skills that are known to cause possible tips or falls. If the participant attempted any skill in an unsafe manner, the spotter intervened immediately and gave feedback. The nature of any adverse incidents was recorded. Fingerless gloves were made available, and most participants wore them.

Data Analysis

The data were entered into an Access (1997) database.[a] From the WST data, as specified in the WSP manual,[12] a total percentage WST score was calculated using an Excel[a] spreadsheet; the numerator was the raw score (the total number of skills passed out of 57), and the denominator was the total possible score (57 minus the number of skills that were not applicable because the wheelchair did not have the part). Subtotal percentage scores were similarly calculated for each of the 3 WST skill levels (indoor, community, advanced).

For statistical software, we used Excel (2000)[a] and Minitab.[b] The data from 2 additional participants (see later) who dropped out of the study and were replaced were not included in the statistical analysis. Descriptive statistics were calculated. The comparability of the WSTP and control groups was assessed with respect to sex and diagnosis (χ^2 test); previous wheelchair experience and the interval between WST 1 and WST 2 (Wilcoxon test); and age, baseline WST, PIADS, and QUEST scores (2-sample *t* tests).

To examine the normality of the WST percentage change-score data, we used the Shapiro-Wilk test. Having determined that not all data were normal, we used nonparametric statistics for the comparisons. The total percentage WST change scores (differences between WST 1 and WST 2) of the WSTP and control groups were compared using a Wilcoxon rank-sum test. Sign tests were used for within-group comparisons of the WST 1 and WST 2 total percentage scores. Between- and within-group comparisons for the subtotal percentage WST scores were similarly evaluated. Statistical significance was defined as *P* less than .05 for the primary outcome measure, the between-group comparison of the pre- and posttraining improvements in total WST scores. Bonferroni adjustments for multiple comparisons were made (to α=.0045 [.05/11] for subtotal percentage scores and to α=.0025 [.05/20] for demographic, clinical, and wheelchair data). The individual skill success rates were

Table 2: WST Total and Subtotal Percentage Scores

Score	WSTP			Control			WSTP vs Control
	WST 1	WST 2	P*	WST 1	WST 2	P*	P
Total	63.3±6.0	78.5±8.3	<.001	70.8±14.0	74.2±11.8	NS	<.005
Indoor	91.4±8.2	98.1±2.6	NS	95.3±5.9	97.5±4.5	NS	NS
Community	68.5±16.4	90.5±8.9	.001	72.9±24.2	82.2±17.4	NS	NS
Advanced	1.4±3.0	27.7±31.5	NS	18.6±39.2	20.0±38.6	NS	NS

NOTE. Values are mean ± SD. The threshold for statistical significance (α) was .05 for the between-group comparison of the pre- and posttraining improvements of total WST scores, but was Bonferroni adjusted to .0045 (.05/11) for all other comparisons. Those comparisons that were statistically significant after Bonferroni adjustment are shown.
Abbreviation: NS, not statistically significant.
*Within-group comparisons.

evaluated qualitatively because there would not have been adequate power for a statistical analysis.

RESULTS

Participants

Figure 1 shows the participant flow according to the CONSORT guidelines.[24] The estimated prevalence of community-dwelling wheelchair users in Nova Scotia was based on an earlier study.[25] In addition to the 20 participants who completed the study, there were 2 dropouts, both from the control group. One dropout decided not to continue due to lack of interest in this study. The other dropout was admitted to a long-term care facility after completing the initial wheelchair skills evaluation and no longer met the inclusion and exclusion criteria.

The group comparability data for participants are summarized in table 1. The WSTP and control groups were not significantly different for age, sex, diagnostic group, living arrangement, previous wheelchair experience, frequency of wheelchair use, method of wheelchair propulsion, and QUEST scores or PIADS scores. The mean ± SD interval between WST 1 and 2 was 69.4±35.2 days (median, 48.5d) for participants in the WSTP group and 81±61 days (median, 39d) for participants in the control group (P=.54).

Wheelchairs

Wheelchair usage data are provided in table 1. The specifications of the manual wheelchairs used by participants in the 2 groups in WST 1 were qualitatively similar. All wheelchairs were rear-wheel drive and had toggle brakes. Most wheelchairs were lightweight and had folding frames, sling seats, cushions, front rigging, armrests that could be moved out of the way, and rear anti-tip devices. One subject in the WSTP group changed from a conventional to a lightweight wheelchair between WST 1 and WST 2.

Total and Subtotal WST Percentage Scores

The total and subtotal percentage WST scores are shown in table 2 and illustrated in figure 2. There was no significant difference between groups for WST 1 (P=.14). The WSTP group had significantly greater improvements in total WST score than the control group ($P \leq .005$). The mean total WST score for the WSTP group increased significantly from 63.3%±6.0% to 78.5%±8.3%, a relative increase of 24.0% (P<.001). The control group increased to a nonsignificant extent, from 70.8%±14.0% to 74.2%±11.8%, a relative improvement of 4.8% (P=.03). To explore whether the results were affected by the participant in the WSTP group who changed from a conventional to a lightweight wheelchair between WST 1 and WST 2, we repeated the statistical analyses without this participant. The extent and significance of the differences were not materially different.

Of the subtotal scores, after Bonferroni adjustment, within-group comparisons showed a significant improvement only for the community skill level of the WSTP group, whose mean score increased from 68.5%±16.4% to 90.5%±8.9%, a relative improvement of 32.2% (P=.002). This improvement was not significantly greater than the 12.7% increase seen in the control group.

Individual Skills

The success rates for individual skills are shown in table 3. The success rates of 25 of the 57 individual skills improved by at least 20% (the threshold that we defined as being clinically significant) between WST 1 and WST 2 for participants in the WSTP group, compared with only 5 skills that met this threshold for the control group. No success rates decreased between WST 1 and WST 2 for either group. For the subset of participants for whom timing data were available for the street-crossing skill (the only timed skill), neither group had a change in speed from WST 1 to WST 2 that was clinically significant and there was no statistically significant difference between the groups (P=.84). The speeds ranged from 1.13 to 1.36m/s.

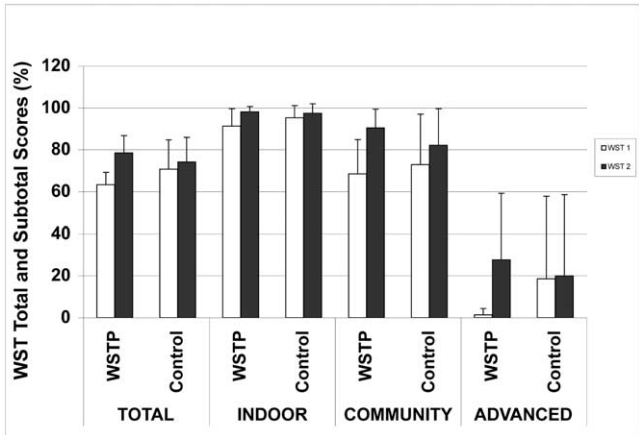

Fig 2. Total and subtotal percentage WST scores pre- (WST 1) and posttraining (WST 2) for the WSTP and control groups.

Table 3: Success Rates for Individual Wheelchair Skills

		WSTP				Control			
		WST 1		WST 2		WST 1		WST 2	
Skill	Skill Level	N	%	N	%	N	%	N	%
Apply brakes*	Indoor	10	100	10	100	10	100	10	100
Release brakes*	Indoor	10	90	10	100	10	100	10	100
Remove armrests*	Indoor	9	78	9	100	9	78	9	89
Restore armrests*	Indoor	9	78	9	100	9	78	9	89
Remove footrests*	Indoor	7	86/83	7	100	6	100	6	100
Restore footrests*	Indoor	7	86/83	7	100	6	100	6	100
Rolling forward	Indoor	10	100	10	100	10	100	10	100
Rolling backward	Indoor	10	100	10	100	10	100	10	100
Turn in place*	Indoor	10	90	10	100	10	90	10	90
Moving turn forward*	Indoor	10	100	10	100	10	100	10	100
Moving turn backward*	Indoor	10	100	10	100	10	100	10	100
Carpet	Indoor	10	90	10	100	10	100	10	100
Sideways maneuvering*	Indoor	10	100	10	100	10	100	10	100
Reaching floor	Indoor	10	100	10	100	10	100	10	100
Reaching high object	Indoor	10	40	10	70	10	70	10	90
Transfer out	Indoor	10	100	10	100	10	100	10	100
Transfer in	Indoor	10	100	10	100	10	100	10	100
Door away	Indoor	10	100	10	100	10	100	10	100
Door toward	Indoor	10	100	10	100	10	100	10	100
Threshold low	Indoor	10	90	10	100	10	100	10	100
Street crossing	Community	6	100	10	100	7	100	10	100
Threshold high	Community	10	0	10	30	10	0	10	0
Fold wheelchair	Community	9	67	9	89	10	70	10	100
Open wheelchair	Community	9	44	9	89	10	70	10	90
Cross slope*	Community	10	100	10	100	10	100	10	100
Incline ascent	Community	10	90	10	100	10	70	10	100
Incline descent	Community	10	90	10	100	10	90	10	90
Gravel	Community	10	70	10	90	10	80	10	80
Potholes, small	Community	10	70	10	100	10	70	10	80
Potholes, large	Community	10	50	10	100	10	50	10	80
Small curb ascent	Community	10	40	10	100	10	70	10	80
Small curb descent	Community	10	80	10	100	10	90	10	90
Large curb ascent	Advanced	10	0	10	20	10	0	10	0
Large curb descent	Advanced	10	30	10	70	10	20	10	30
Wheelie, stationary	Advanced	10	0	10	30	10	20	10	20
Wheelie, rolling forward	Advanced	10	0	10	20	10	20	10	20
Wheelie, rolling backward	Advanced	10	0	10	10	10	20	10	20
Wheelie, turn in place*	Advanced	10	0	10	20/30	10	20	10	20
Wheelie, moving turn forward*	Advanced	10	0	10	30	10	20	10	20
Wheelie, moving turn backward*	Advanced	10	0	10	20	10	20	10	20
Wheelie, no hands rest	Advanced	10	0	10	30	10	20	10	20
Wheelie, incline descent	Advanced	10	0	10	10	10	20	10	20
Wheelie, high curb descent	Advanced	10	0	10	30	10	20	10	20

*Only a single value is shown for left and right-sided skills when the 2 values were identical. Where they were different, both are shown (left/right).

Safety

There were no adverse events during testing or training. However, because practicing wheelie-dependent skills usually resulted in rear tips, the spotter often had to use the spotter strap to catch the participants in the WSTP group during training.

Practicality

Participants in the WSTP group completed a mean of 4.5 ± 0.7 hours of training (range, 3–5h). All participants in the WSTP group were able to come to the rehabilitation center for at least 1 training session, and 3 (30%) participants completed all training there. The trainer traveled to the homes and communities of 7 participants (70%), 4102km in total. These participants experienced problems getting to the rehabilitation center due to distance, available transportation, scheduling conflicts, and/or weather.

The trainer was able to find skill settings in the participants' homes and nearby communities that were reasonably similar to those in the rehabilitation center and as specified in the WSP manual.[12] Examples of indoor skill settings found within the home included reaching a glass from a cupboard for the high-reach skill or turning into small rooms from the hallway for the moving-turns skill. While driving to the participants' homes,

Table 4: Summary of WSTP Training Studies

Group	Parameter	MacPhee et al[8]	Coolen et al[7]	Kirby et al[9]	Current Study
WSTP	n	15	22	24	10
	Pretraining	64.9±9.4	64.8±9.0	77.8±12.0	63.3±6.0
	Posttraining	80.9±5.6	81.0±5.2	94.7±7.1	78.5±8.3
	Change (%)*	24.7	25.0	21.7	24.0
	P	<.001	<.001	<.001	.002
Control	N	20	18	NA	10
	Pretraining	60.1±14.4	66.0±8.0	NA	70.8±14.0
	Posttraining	64.9±13.3	72.4±7.1	NA	74.2±11.8
	Change (%)*	8.0	9.7	NA	4.8
	P	.01	.015	NA	.03
WSTP vs control	*P*	<.001	.005	NA	<.005

NOTE. Values are mean ± SD or as indicated.
Abbreviation: NA, not applicable.
*The change values represent the differences between the pre- and posttraining mean total WST scores, expressed as a percentage of the pretraining values.

the trainer observed the community to locate appropriate settings for the community and advanced skills training. The participants helped the trainer to identify suitable locations. Inclines, gravel, potholes, and curbs were all found reasonably near the participants' homes, but finding a nearby obstacle similar to the high threshold was usually a problem.

Qualitative Observations

Family and friends were involved in at least some of the WSTP training sessions for 80% of the participants. When training in participants' homes, the trainer was able to provide caregiver advice. All participants reported that they felt the WSTP was enjoyable and had improved their wheelchair skills and confidence. Many commented that, without training, they would not have attempted some of the community and advanced skills. Nine participants (90%) in the WSTP group liked the option of training in their homes or communities. Some suggestions made by participants for improving this type of training in the future were to help with organizing transportation, to provide training in groups, to teach people how to fall and get back into their chairs, to include snow and ice, and to have more training sessions.

Examples of verbatim participant comments were "I figured out a lot on my own, but training has improved my skills"; "I can't believe how much I've learned in such a short period of time"; "Now that I know more wheelchair skills, the thought of using the wheelchair fulltime isn't as scary"; "Training wouldn't have been possible for me if you did not come to my house"; "I feel that my confidence with a wheelchair has improved"; and "I feel less embarrassed in my wheelchair when I am out."

DISCUSSION

We achieved our objective, corroborating the hypotheses that wheelchair skills training of community-based manual wheelchair users is efficacious, safe, and practical. The WSTP group improved to a significantly greater extent than the control group. This study replicates, in a new setting, the results of the 3 previous studies in which the WSTP has been evaluated. The extent of improvement in wheelchair skills found in the present study was similar to those previously reported (table 4).[7-9]

The participants in this study, although a sample of convenience, appeared to be reasonably representative of the target population. The mean total WST percentage scores at intake were 67%. This was similar to the mean discharge score of 65% for the control group in the MacPhee study[8] in a rehabilitation center. The WSTP and control groups were comparable from the perspectives of all the demographic, clinical, and wheelchair-related parameters that we evaluated nor were there any significant differences in baseline wheelchair skills performance. The descriptive data on wheelchair satisfaction (QUEST) and psychosocial impact (PIADS) suggest that community-based wheelchair users are moderately positive about their wheelchairs and their usefulness.

Because the participants were community-based manual wheelchair users, we were not surprised that wheelchair performance on indoor skills was greater than 90% for both groups at intake and that the pre- and posttraining differences were not significant. The WSTP group had a clinically and statistically significant pre- and posttraining mean improvement of 32.2% in community skills. Although participants in the control group improved in community skills, this was not statistically significant. With the small sample size we evaluated, this study was underpowered to detect a difference of this magnitude. However, some improvement for the control group would not have been unexpected because some of the participants had only recently completed their inpatient rehabilitation. Furthermore, the intake assessment of wheelchair skills might have stimulated participants in the control group to self-learn some of the skills with which they had difficulties. Because of a lack of power, statistical analysis of the individual skills was beyond the scope of this study. However, participants in the WSTP group had improvements in success rates that were clinically significant for 44% of the skills (in comparison with only 9% for the control group), particularly within the community and advanced skill levels.

The community-based WSTP appears to be safe and well tolerated. The presence of family and friends appears to be motivational. Regarding practicality, the WSTP group required an average of 4.5 hours of training, slightly greater than the 0.8 to 2.25 hours for the previous WSTP studies.[7-9] Although the trainer had to travel to the homes and communities of 70% of the participants, the wheelchair users' homes and surrounding communities proved to be generally suitable settings for training. Training in the community had the advantages of being realistic, being personalized, providing high contextual interference (known to enhance retention),[20,26] and minimizing concerns about "training to the test."

Although not formally studied, an estimate of the direct costs (in Canadian dollars) for providing wheelchair skills training in the community can be made. The estimated cost of personnel per trainee includes a clinician trainer (≈$24/h) to provide 4.5 hours of training, as well as 5.1 hours of travel time (an average of 410km per participant at 80km/h) for each wheelchair user. The total personnel cost would be $230 (9.6h×$24). The cost of travel was estimated to be $0.33/km or $132 per trainee. The total direct costs would therefore be $365 per trainee. Although not insignificant, this cost is minor in comparison with many other health care costs. Furthermore, an initial investment in wheelchair skills training provides ongoing benefits without ongoing costs (eg, unlike many medications, for instance). To the extent that improvements in wheelchair skills might translate into reduced needs for caregiver support, reduced incidence of institutionalization, reduced incidence of injuries, or increased incidence of returning to gainful employment, the WSTP has the potential to provide financial benefits that greatly exceed its costs.

Limitations of this study include the small sample of convenience studied. Also, there were a number of potentially confounding variables that could not be controlled for in this study. The variation in how the WST outcomes were collected (in the rehabilitation center, in the community, and by means of the WST-Q) was also a limitation. Studying a larger number of participants would have allowed us more flexibility in dealing with the difficulties some participants had in returning to the rehabilitation center for posttesting. The skill settings differed slightly from person to person, and all skill settings were not present in every participant's environment. However, the net effect of these limitations would only have increased the difficulty of corroborating the hypothesis (type I error); that the hypothesis was corroborated, despite these difficulties, only strengthens the conclusions. Another limitation is that the control group did not receive any placebo intervention. It is possible that the social interactions with the trainer, rather than the actual training, accounted for the improvements in the WSTP group.

Possibilities for future research include replication with a larger sample size, a broader range of ages, and more diverse community settings. It would be useful to explore which elements of the training protocol or the characteristics of the participants accounted for the improvements. The participants in the WSTP group in this study did not receive formal WSTP training during their initial rehabilitation.[8] It would be interesting to determine the extent to which the advanced skills might have been better learned if the participants had begun the WSTP during their initial rehabilitation. Better understanding is needed about caregiver training, what types of practice might safely take place outside of the formal training sessions, how long-term retention could be enhanced, and the impact of wheelchair skills training on QOL.

CONCLUSIONS

Despite the study limitations and the need for further study, this is the first randomized controlled trial to document the efficacy, safety, and practicality of wheelchair skill training in the community. Our results, although preliminary, are encouraging and suggest that a greater focus on training would be useful for improving the safety, activities, and participation of community-based manual wheelchair users.

Acknowledgments: We thank John Kozey, PhD, Diane MacKenzie, MSc, David Westwood, PhD, Jerome Singleton, PhD, and Kara Thompson, MSc, for their advice.

References

1. Hoenig H, Landerman LR, Shipp KM, George L. Activity restrictions among wheelchair users. J Am Geriatr Soc 2003;51:1244-51.
2. Meyers AR, Anderson JJ, Miller DR, Shipp K, Hoenig H. Barriers, facilitators, and access for wheelchair users: substantive and methodologic lessons from a pilot study of environmental effect. Disabil Rehabil 2002;15:106-14.
3. Ummat S, Kirby RL. Nonfatal wheelchair-related accidents reported to the National Electronic Injury Surveillance System. Am J Phys Med Rehabil 1994;73:163-7.
4. Gaal RP, Rebholtz N, Hotchkiss RD, Pfaelzer PF. Wheelchair rider injuries: causes and consequences for wheelchair design and selection. J Rehabil Res Dev 1997;34:58-71.
5. Curtis KA, Drysdale GA, Lanza RD, Kolber M, Vitolo RS, West R. Shoulder pain in wheelchair users with tetraplegia and paraplegia. Arch Phys Med Rehabil 1999;80:453-7.
6. Boninger ML, Towers JD, Cooper RA, Dicianno BE, Munin MC. Shoulder imaging abnormalities in individuals with paraplegia. J Rehabil Res Dev 2001;38:401-8.
7. Coolen AL, Kirby RL, Landry J, et al. Wheelchair skills training program for clinicians: a randomized controlled trial with occupational therapy students. Arch Phys Med Rehabil 2004;85:1160-7.
8. MacPhee AH, Kirby RL, Coolen AL, Smith C, MacLeod DA. Wheelchair skills training program: a randomized clinical trial on wheelchair users undergoing initial rehabilitation. Arch Phys Med Rehabil 2004;85:41-50.
9. Kirby RL, Mifflen NJ, Thibault DL, et al. The manual wheelchair-handling skills of caregivers and the effect of training. Arch Phys Med Rehabil 2004;85:2011-9.
10. Bullard S, Miller SE. Comparison of teaching methods to learn a tilt and balance wheelchair skill. Percept Mot Skills 2001;93:131-8.
11. Bonaparte JP, Kirby RL, MacLeod DA. Learning to perform wheelchair wheelies: comparison of 2 training strategies. Arch Phys Med Rehabil 2004;85:785-93.
12. Wheelchair Skills Program manual. Version 3.1. Available at: http://www.wheelchairskillsprogram.ca/. Accessed July 16, 2005.
13. Kirby RL, Swuste J, Dupuis DJ, MacLeod DA, Monroe R. The Wheelchair Skills Test: a pilot study of a new outcome measure. Arch Phys Med Rehabil 2002;83:10-8.
14. Kirby RL, Dupuis DJ, MacPhee AH, et al. The Wheelchair Skills Test (version 2.4): measurement properties. Arch Phys Med Rehabil 2004;85:794-804.
15. Day H, Jutai J, Campbell KA. Development of a scale to measure the psychosocial impact of assistive devices: lessons learned and the road ahead. Disabil Rehabil 2002;24:31-7.
16. Jutai J. Quality of life impact of assistive technology. Rehabil Eng 1999;14:2-7.
17. Demers L, Monette M, Lapierre Y, Arnold D, Wolfson C. Reliability, validity, and applicability of the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0) for adults with multiple sclerosis. Disabil Rehabil 2002;24:21-30.
18. Demers L, Weiss-Lambrou R, Ska B. Item analysis of the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST). Assist Technol 2001;12:96-105.
19. Brashers-Krug T, Shadmeht R, Bizzi E. Consolidation in human motor memory. Nature 1996;382(6588):252-5.
20. Shea CH, Kohl R, Indermill C. Contextual interference: contributions of practice. Acta Psychol (Amst) 1990;73:145-57.
21. Newton AM, Kirby RL, MacPhee AH, Dupuis DJ, MacLeod DA. Evaluation of manual wheelchair skills: is objective testing necessary or would subjective estimates suffice? Arch Phys Med Rehabil 2002;83:1295-9.

22. Mountain AD, Kirby RL, Smith C. The Wheelchair Skills Test: validity of an algorithm-based questionnaire version. Arch Phys Med Rehabil 2004;85:416-23.
23. Kirby RL Lugar JA. Spotter strap for the prevention of wheelchair tipping. Arch Phys Med Rehabil 1999;80:1354-6.
24. Begg C, Cho M, Eastwood S, et al. Improving the quality of reporting of randomized controlled trials. The CONSORT statement. JAMA 1996;276:637-9.
25. Kirby RL, Ackroyd-Stolarz SA, Brown MG, Kirkland SA, MacLeod DA. Wheelchair-related accidents caused by tips and falls among noninstitutionalized users of manually propelled wheelchairs in Nova Scotia. Am J Phys Med Rehabil 1994;73:319-30.
26. Li Y, Lima RP. Rehearsal of task variation and contextual interference effect in a field setting. Percept Mot Skills 2002;94:750-2.

Suppliers

a. Microsoft Corp, 320 Matheson Blvd, Mississauga, ON L5R 3R1.
b. Version 13; Minitab Inc, 3081 Enterprise Dr, State College, PA 16801-3008.