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Effectiveness of Group Wheelchair Maintenance Training for People with Spinal Cord Injury: A Randomized Controlled Trial

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Abstract

Objective: To assess the effectiveness of group wheelchair maintenance training and investigate participant characteristics associated with responsiveness to training.

Design: Randomized control trial with an immediate group and waitlist control group (WLCG) who received the intervention after a 6-month delay.

Setting: Four Spinal Cord Injury Model Systems Centers.

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Conflicts of Interest: None to disclose.

Clinical Trial Registration Number: NCT01807728

Participants: Manual (MWC) and power wheelchair (PWC) users with spinal cord injury (n=80 and 67, respectively).

Intervention: Two 90-minute structured wheelchair maintenance training program classes with 12-20 people per class and separate classes for MWC and PWC users. Each class included in-person hands-on demonstrations and practice of wheelchair maintenance.

Main Outcome Measures: Separate analysis was completed for MWC and PWC users using the Wheelchair Maintenance Training Questionnaire (WMT-Q) capacity (ability to complete), performance (frequency of completion) and knowledge at baseline, 1-month, 6-month, 6-month-pre-training (WLCG only), and 1-year (immediate only).

Results: Following the intervention, participants in both the immediate and WLCG improved in maintenance capacity (MWC and PWC, $p<0.001$) and performance (MWC and PWC, $p<0.001$) with training. Only PWC users improved knowledge of wheelchair maintenance ($p<0.001$). For both WLCGs (MWC and PWC) there was no difference between the 6-month-pre-training time-point and baseline. MWC users who responded to training had lower WMT-Q scores for all domains while for PWC users this was only the case for knowledge.

Conclusions: Group wheelchair skills training is effective at improving capacity to complete maintenance and performance of maintenance activities for MWC and PWC users, even in a cohort of experienced wheelchair users. For MWC users improvements were tied to lower WMT-Q scores at baseline, while PWC users improved in capacity and performance independent of baseline score. Delivering this training in a structured group format is lower cost and therefore might improve adoption into clinical practice.

Keywords

Group training; Maintenance; Wheelchair; Spinal cord injuries; Rehabilitation

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Wheelchair breakdowns are a common occurance, with 45-63% of wheelchair users reporting breakdowns within the previous 6 months.[1–4] Adverse consequences are common secondary to breakdowns with recent studies reporting an incidence of greater than 40%.[5,6] Further, those requiring longer repair times were more likely to experience adverse consequences.[5]

Preventive maintenance may play a role in mediating these effects and addressing the rising incidence of wheelchair repairs.[7,8] Regular maintenance is associated with a decreased incidence of wheelchair-related accidents.[9,10] Previous work has also demonstrated the effectiveness of a Wheelchair Maintenance Training Program for improving maintenance proficiency of clinicians.[11,12] As such, the World Health Organization recognizes wheelchair maintenance and repairs as one of the eight steps of wheelchair provision,[13] with both maintenance and repairs needed to ensure the seating system and wheelchair remain safe and functional.[7] Recommended frequency for maintenance tasks vary in frequency from daily to annually.[11,12]

Despite these findings, clinicians and wheelchair users lack training in wheelchair maintenance.[14] Of 31 entry-to-practice occupational and physical therapy programs in Canada, only 5 (16%) include wheelchair maintenance and repairs as part of their curriculum.[15] Thus, it is not surprising that maintenance and repair were the least common manual wheelchair skills training interventions in practice with 42% of Canadian rehabilitation centers never providing this type of training to patients and 46% providing it only sometimes or rarely.[16] Incidence of wheelchair maintenance training has not been reported in literature for the United States.

In addition to limited clinician knowledge regarding wheelchair maintenance, other barriers include short lengths of stay during acute rehabilitation, other rehabilitation priorities during outpatient therapy, and demanding caseloads resulting in decreased time and resources on the part of the clinician. Group training provides a potential solution to these barriers, lending itself to a format where a clinician can provide an intervention to multiple users simultaneously in a variety of settings (inpatient, outpatient, or remote). This training method has been shown to be effective for administering manual wheelchair (MWC) skills training.[17] The primary objective of this study was to evaluate the effectiveness of a structured group wheelchair maintenance training to improve capacity (ability to complete), performance (frequency of completion) and knowledge of wheelchair maintenance among individuals with SCI. The secondary objective was to learn what participant characteristics are associated with training benefits.

METHODS

Study design

This was a randomized control trial utilizing a waitlist control group (WLCG). The immediate group completed study assessments and activities in the following order: baseline, intervention, 1-month, 6-month, 1-year. The WLCG completed studies in the following order: baseline, 6-month-pre-training, intervention, 1-month, 6-month. For the WLCG, 6-month-pre-training occurred at the same time as the 6-month assessment for the immediate group and consisted of the same assessments.

Setting

Participants were enrolled at four Spinal Cord Injury Model Systems Centers: Midwest Regional SCI Care System, Northern New Jersey SCI System, South Florida SCI System, and University of Pittsburgh Model Center on SCI.

Group Allocation

Separate trainings were held for MWC and power wheelchair (PWC) users at each site. Participants were randomized to either an immediate or WLCG using permutated blocks of 2 or 4 based on level of injury (paraplegia, tetraplegia) and years since injury (<1 year, ≥1 year). Group assignment codes were generated before the start of the study for a 1:1 allocation ratio by the study biostastician. Allocation was concealed with study members at individual sites contacting the study coordinator at the lead site before baseline testing to receive the group assignment. WLCG participants were told that they were scheduled in the next available intervention in 6 months.

Ethical issues

Institutional Review Board approval was obtained at each site and participants provided written informed consent for participation.

Recruitment and Screening

A convenience sample was recruited between March 2015 and January 2017 through advertisements, research registries, and word of mouth. Eligiblity criteria were age 18 to 75 years, wheelchair users secondary to a non-progressive SCI, used wheelchairs as their primary means of mobility (>50% of weekly mobility), resided in the community, and had Mini-Mental State Examination scores ≥23. Individuals who were not able to complete maintenance themselves were asked to bring a caregiver or assistant who could assist with maintenance at home or were provided with a volunteer unfamiliar with wheelchair maintenance who they could direct to do the maintenance under their guidance.

Sample Size

Hansen et al., [10] reported that the number of wheelchair accidents decreased by 100% after a maintenance intervention while there was no decrease in number of accidents for control subjects. By taking a conservative approach and assuming a medium effect size, we would have over 90% power to detect significant differences with a total sample size of 140 participants. Enrollment concluded after recruitment goals were met.

Intervention

At each site participants attended two classes, each 120 minutes in length. Two make-up classes were offered as necessary. Class sizes ranged from 4-7 wheelchair users to reflect likely group training sizes in a clinical setting. Each class was taught by two trainers who received training from content experts, as described in a previous publication.[11] Class 1 included an introduction (5 minutes), overview of objectives and relevance (15 minutes), instructional video on how to take care of a wheelchair at home (5 minutes), didactic and demonstration of caring for a wheelchair at home (60 minutes), and a summary (5 minutes). Class 2 consisted of hands-on wheelchair maintenance guided by a checklist (90 minutes), and a summary and discussion (25 minutes). Trainers at each site completed a 1-day training in-person train-the-training with 2 content experts. Intervention fidelity was addressed through the use of a reference manual and annotated PowerPoint presentation and consistent lesson plans, hands-on activity checklists, maintenance cards, and educational videos across sites. Links to these materials can be found here – [url removed for blinding]. Participants received a printed or digital copy of the slide presentation to enable note-taking. To maximize attendance at both classes, participants received their toolkit and checklist at the second class. A copy of the checklist and list of items in the toolkit can be found in the Supplementary Material.

Demographic, clinical, and wheelchair measures

The following data were collected at baseline: age, sex, body mass index, race, highest level of formal education, occupation, income, SCI level (tetraplegia [C8 and higher] vs paraplegia [below C8]), length of time using a wheelchair, and age of wheelchair used most often.

Wheelchair Maintenance Training Questionnaire (WMT-Q)

The Wheelchair Maintenance Training Questionnaire (WMT-Q) evaluates the knowledge of wheelchair maintenance and frequency of wheelchair maintenance performance of wheelchair users.[11] The MWC or PWC version of the WMT-Q were used accordingly.

The WMT-Q was completed electronically using Qualtrics Survey Software. Each version of the WMT-Q has three domains: capacity, performance and knowledge. Capacity questions (n=20 MWC, n=21 PWC) asked, "Do you (or your caregiver) know how to do the maintenance skill?" with response options of "yes", "no" or "not possible." If the participant reported the capacity to accomplish a maintenance skill, they were then asked about performance, "How often do you actually do this skill during your daily life?", with response options of daily, weekly, monthly, quarterly, yearly, or never. The Knowledge domain (n=15 MWC, n=18 PWC; 13 common question) consisted of multiple choice and true/false questions related to the importance of maintenance practice such as, "How many times more likely are you to sustain an injury if you do not maintain your wheelchair?" with response options of "No increased likelihood, two times more likely, five times more likely, ten times more likely"; both question types included "I don't know" as a response to discourage guessing. Scoring for each domain of the WMT-Q was as follows:

$$\text{Capacity} = \frac{\Sigma Tasks\ answered\ Yes}{Total\ Possible\ -\ Not\ Possible} * 100$$

$$\text{Performance} = \frac{\Sigma Tasks\ completed}{capacity\ Denominator} * 100$$

$$\text{Knowledge} = \frac{\Sigma Correct\ answers}{Total\ Possible\ Answers} * 100$$

Follow-Up Data Collection

Participants repeated the WMT-Q at 1-month and 6-months after training. In addition, the immediate group completed a 1-year follow-up while the WLCG completed a 6-month pre-training follow-up (identical to the 6-month follow-up). Participants received 3-month reminders by either phone call, text message or email to remind them of upcoming training or follow-up.

Data Analysis

Participants included in data analysis completed at least 1 follow-up assessment time point. Generalized Estimating Equations (GEE) were used to examine between and within group differences in WMT-Q scores. A sensitivity analysis was competed for WMT-Q between group differences using intention-to-treat analysis, specifically last observation carried forward, to evaluate the effects of missing data for participants missing follow-up data.

For consistency with previous publications on disparities in wheelchair performance,[1–3] the following variables were recoded: race was dichotomized to White and minority (Black, other); level of education was recoded to high school or less, 2-4 years of college, and graduate degree; occupation was dichotomized to working, student, or on-the-job training and retired, homemaker, unemployed or other. A dichotomous variable was created for responsiveness to training (improved vs stayed the same/decreased) for each WMT-Q domain to indicate an improvement in scores at 1-month-post training. Chi-square and independent t-tests were used to investigate factors associated with responsiveness to training and between group differences (immediate vs. WLCG) at baseline for the following demographic characteristics: wheelchair type, age, years since injury, years of wheelchair use, race, gender, level of injury, level of education, and occupation. All statistical analyses were completed using IBM SPSS version 26.

RESULTS

Participants

Of the 147 individuals enrolled in this study, there were 80 MWC users and 67 PWC users. Participation in each study time point for those who did and did not complete the intervention are found in Figure 1. Completion rates at baseline, 1-month-post, and 6-month-post were 70%, 55%, and 51% respectively. 96% of immediate and 70% of WLCG completed the assessment immediately before training (baseline and 6-month-pre-training, respectively). Baseline testing was completed by 97% and 93% of MWC and PWC participants, respectively.

Fifty-six percent of participants had paraplegia with an average (SD) of 14.1 (11.3) years of wheelchair use. Additional demographic characteristics can be found in Table 1. The only between group difference based was a lower percentage of minorities in the immediate group compared to the WLCG. Comparing those who did complete all assessments to those who did not, there were no significant differences between groups (Supplementary Material). Further, sensitivity analyses demonstrated that the results for the full sample were similar in magnitude, direction and extent of statistical significance to those for the 147 participants who met inclusion for data analysis (Supplementary Material).

WMT-Q Between Groups

Following the intervention, there were no differences between the immediate and WLCG for MWC users between baseline and subsequent time points for capacity (χ^2 (1)=0.25 p=.621, 95% CI (−16.44, 9.806)), performance (χ^2 (1)=0.25 p=.617, 95% CI (−15.88, 9.414)), or knowledge (χ^2 (1)=0.5 p=.479, 95% CI (−8.29, 3.888)),). There were also no differences for PWC users for capacity (χ^2 (1)=0.16 p=.69, 95% CI (−8.782, 5.81)), performance (χ^2 (1)=0.054 p=. 816, 95% CI (−16.44, 9.806)), or knowledge (χ^2 (1)=1.007, p=.316, 95% CI (−8.259, 6.502)) between baseline and subsequent time points following the intervention.

WMT-Q Capacity:

There were statistically significant gains in MWC WMT-Q capacity scores, χ^2 (4)=25.95 p<.001, 95% CI (4.819,15.608) (Figure 2a). Following the training, MWC WMT-Q capacity scores were significantly higher at 1-month (36%), 6-months (42%), and 1 year (38%), compared to baseline scores (26%). All pairwise comparisons were significant at the *p*<.001 level. MWC WMT-Q capacity for the WLCG 6-month-pre-training time point did not differ from baseline (29%).

PWC users also demonstrated a significant increase in capacity scores, χ^2 (4)=41.76*p*<.001, 95% CI (23.698,36.372) (Figure 2a). Correspondingly, PWC WMT-Q capacity scores were significantly higher at 1-month (89%), 6-months (86%), and 1-year (85%), following the training, compared to baseline scores (59%). All pairwise comparisons were significant at the *p*<.001 level. PWC WMT-Q capacity for the WLCG 6-month-pre-training time point did not differ from baseline (57%).

WMT-Q Performance:

There were statistically significant gains in MWC performance scores, χ^2 (4)=29.78 *p*<.001, 95% CI (6.363,17.293) (Figure 2b). Following the training, participant average scores were significantly higher at 1-month (35%), 6-months (40%), and 1-year (37%), compared to baseline scores (24%). All pairwise comparisons were significant at the *p*<.001 level. MWC WMT-Q performance for the WLCG 6-month-pre-training time point did not differ from baseline (26%).

Similarly, PWC users demonstrated a significant increase in performance scores, χ^2 (4)=41.76*p*<.001, 95% CI (24.462,36.882) (Figure 2b). WMT-Q performance scores were significantly higher at 1-month (85%), 6-months (84%), and 1 year (82%), compared to baseline (55%). All pairwise comparisons were significant at the p<.001 level. PWC WMT-Q performance for the WLCG 6-month-pre-training time point did not differ from baseline (52%).

WMT-Q Knowledge:

Knowledge scores did not change for MWC users over time, χ^2 (1)=6.76 *p*=.149, 95% CI (−1.474,3.356). For PWC users, knowledge scores increased significantly, χ^2 (4)=28.94 *p*<.001, 95% CI (5.233,11.426) (Figure 2c). Following the training, participant average scores for PWC knowledge were significantly higher at 1-month (28%, *p*<.001) and 6-months (23%, *p*=0.028), compared to baseline scores (20%). These changes were not retained at 1-year-post-training (23%). PWC WMT-Q knowledge for the WLCG 6-month-pre-training did not differ from baseline (19%).

Factors associated with responsiveness to training

The percentage of participants who improved in domain score at 1-month follow-up were as follows for MWC and PWC users: capacity (86.00% and 90.91%) performance (86.36% and 88.33%) and knowledge (47.06% and 65.67%). No participant demographic characteristics were associated with responsiveness for any of the WMT-Q domains; however, there were differences based on baseline WMT-Q scores (Figure 3). MWC users who responded to training had lower baseline scores for capacity (t=4.36, p<.001), performance (t=5.37, p<.001), and knowledge (t=4.42, p<.001). PWC users who responded to training had lower baseline scores for knowledge (t=4.82, p<.001).

DISCUSSION

Group wheelchair maintenance training was effective at improving capacity and performance of wheelchair maintenance for MWC and PWC users. This effect was sustained 6-months and 1-year after training. As such, participants were not only more competent in how to complete wheelchair maintenance but they were also doing more maintenance. We did not observe differences between baseline and the 6-month-pretraining control timepoint for the WLCG. This, in conjunction with the similar response to training for both groups, indicates the improvements can be attributed to the training intervention rather than maturation effects.

Only PWC users gained knowledge, though it was not retained at 1 year. Previous studies on maintenance training for students and clinicians showed increases in WMT-Q knowledge from 27% to 59% and 57% to 84%, respectively.[11,12] Knoweldge scores for both MWC and PWC users in our study had wide variability, indicating a wide range of baseline knowledge. The lack of differences between time points may indicate that participants in the study did not find the information contained in the questionnaire meaningful enough to retain from the training (e.g. the number of times more likely someone is to sustain an injury if they do not maintain their wheelchair, which type of wheelchair is more likely to require repairs, policies specific to Medicare funding). Future studies may consider attention to item-level responses following training to determining areas that may warrant additional emphasis.

Participants had been wheelchair users for almost 15 years on average, indicating skill deficits in wheelchair maintenance even among experienced users. This finding is not surprising as wheelchair maintenance training is not a common part of the service delivery process. There were few wheelchair users in the study who were <1 year since injury (3%), perhaps reflecting our recruitment strategy or priorities that did not include participation in research. It may be that new wheelchair users did not regard the topic as important. New users may not have experienced the need for a repair and do not understand the value of preventive maintenance. Unfortunately, when wheelchair breakdowns do happen, they lead to adverse consequences ranging from missing work or school to being stranded in the home or injury.[1–5]

There were no differences in responsiveness to training based on demographic characteristics. This finding suggests that group training is valuable for a broad spectrum of wheelchair users with SCI. Responders, individuals who had higher WMT-Q scores at 1-month compared to baseline, had lower baseline scores for all the MWC WMT-Q domains. This finding is not surprising as lower scores indicate more room for improvement and was similar to previous findings related to group wheelchair skills training that also showed greater improvements among those with lower baseline scores.[17] However, significant differences in baseline scores for responders was only found for WMT-Q knowledge. Thus, improvements in capacity and performance for PWC users were independent of baseline scores, showing all users had the potential for improvement. In addition to providing mobility, PWCs have advanced seating systems important for pressure relief and positioning. While PWC users may have access to a backup wheelchair, it is more likely to be a MWC than a PWC; PWC users are also more likely to experience a breakdown.[1–3,5,6] Lastly, PWC repairs are more likely to require a vendor and take a longer time to complete, compared to some MWC repairs which can be completed in the home by the user or vendor.[2] Together, these factors may have provided additional motivations for learning in this group.

Study Limitations and Future Work

Participants were a convenience sample across 4 SCI Model Systems Centers and may not be representative of the general SCI population. Individuals were aware that the study targeted wheelchair maintenance and may have been motivated to learn the techniques. Sacrificing this aspect of blinding was important as a previous study on wheelchair skills highlighted the limitations of a double blind study design, such as enrolling individuals with high baseline skill or lack of interest in the intervention.[17] Future work should investigate additional effects of maintenance training including the incidence of repairs, consequences, quality of life, and participation. Future studies may also consider comparing 1:1 training to group training to identify potential benefits of either type of training. Further, secondary to the limitations of in-person training as highlighted by the 2020 COVTD-19 global pandemic, future studies may also investigate how maintenance training could be translated to a virtual setting.

Missing data secondary to failure to complete assessment was an issue. Only 70% completed at least two assessments and the intervention and thus were eligible for inclusion in analysis. Decreasing completion rates with follow-up (baseline vs 1-month vs 6-months) suggests the rate of failure to complete assessments may be partly related to the duration of study enrollment. Intervention arm assigned may also be a factor as pre-training assessment was higher for the immediate group. Wheelchair type does not appear to be a factor as there were no differences in baseline completion between groups. Although WLCG designs are attractive alternatives to active control groups delivered conjoint with the intervention, they may increase risk that participants may not complete “pre-intervention” (i.e. “post-waitlist”) assessment.

CONCLUSIONS

Group wheelchair skills training is effective at improving capacity to complete maintenance and performance of maintenance activities for MWC and PWC users, even in those with substantial wheelchair experience. For MWC users, improvements were tied to lower WMT-Q scores at baseline, while PWC users improved in capacity and performance independent of baseline score. Delivering this training in a structured group format offers a proven lower-cost-means for centers to provide traing in this important area.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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List of Abbreviations:

MWC	Manual wheelchair
PWC	Power wheelchair
SCI	Spinal cord injury
WLCG	Wait list control group

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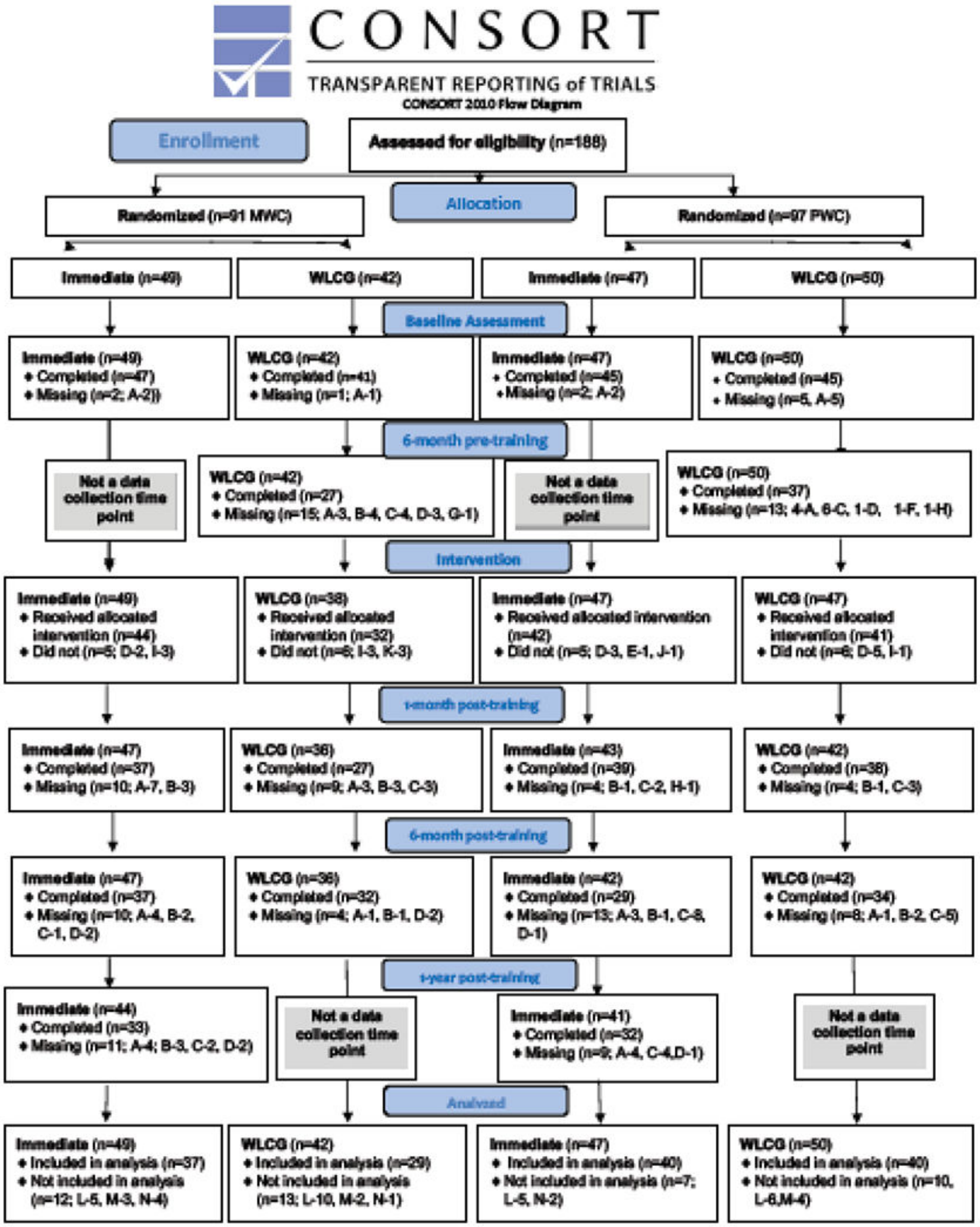

Figure 1:

CONSORT diagram and study flow chart; Abbreviaions for missing data as follows: (A) missing, did not complete WMT-Q; (B) missing, reasons not specified; (C) missing – missed window or unable to contact; (D) participants withdrew, reasons not specified or lost to follow-up; (E) participant withdrew, medical issues; (F) participant withdrew, time and transportation constraints; (G) participant withdrew, switched to MWC to PWC; (H) deceased; (I) did not attend intervention, reasons not specified; (J) did not attend training, out of town; (K) did not attend training, unable to contact; (L) did not complete the intervention; (M) completed only 1 time-point; (N) Missing WMT-Q across all time-points.

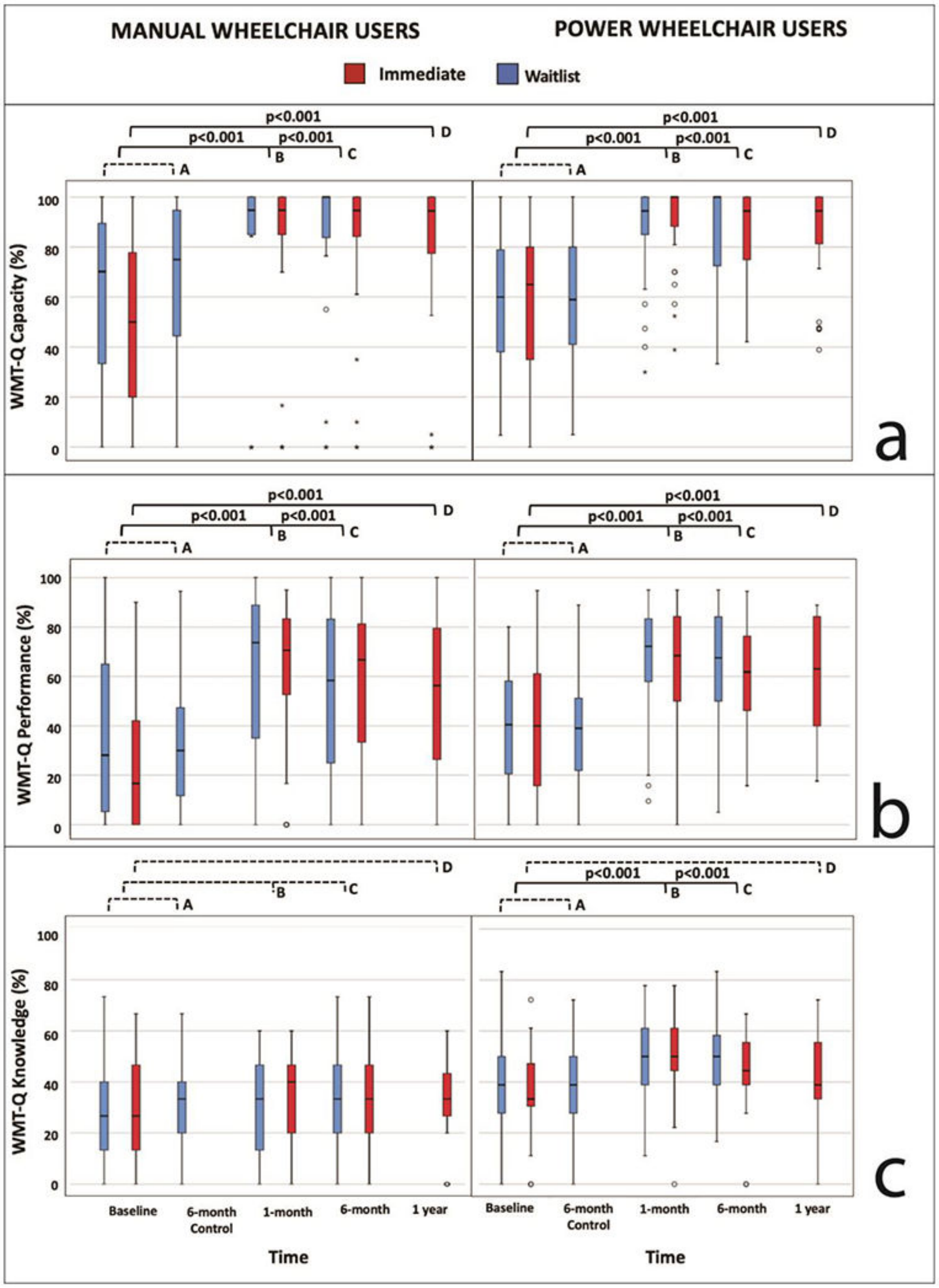

Figure 2:

Wheelchair maintenance capacity [a], performance [b] and knowledge [c] for manual and power wheelchair users across timepoints. Comparisons to baseline shown for 6-months pre-training (A, WLCG only), 1-month post-training (B), 6-months post-training (C), and 1-year post-training (D, immediate group only); dashed brackets indicate no significant differences from baseline while solid brackets indicate significant differences with p-values displayed.

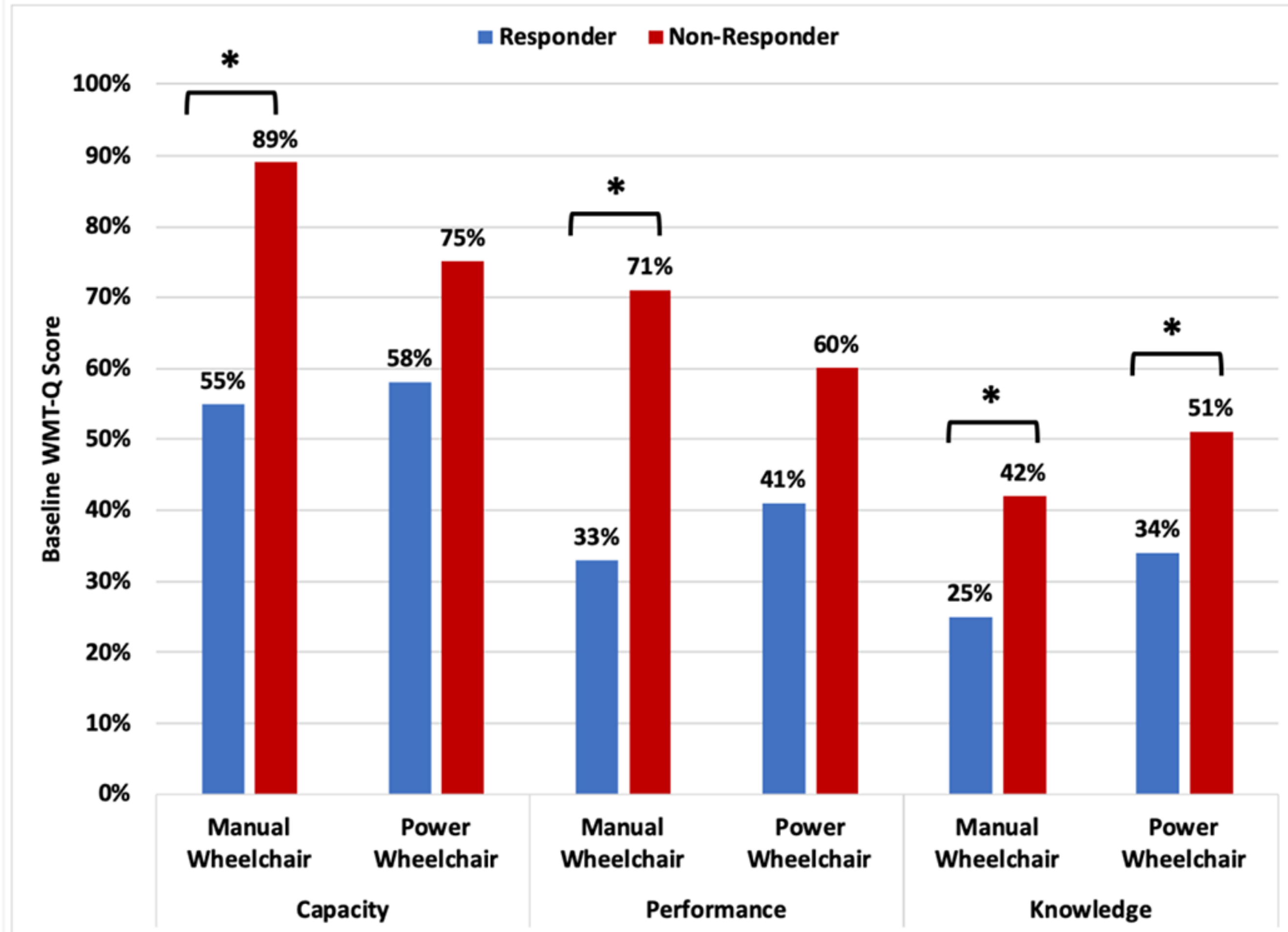

Figure 3:
Differences in baseline WMT-Q scores based on responsiveness to training. Significant differences are noted with a *.

Table 1:

Participant characteristics for immediate and waitlist control groups

Demographics	Manual Wheelchair Users					Power Wheelchair Users				
	Immediate Group (n=37)		Waitlist Control Group (WLCG) (n=29)		Difference Between Groups	Immediate Group (n=40)		Waitlist Control Group (WLCG) (n=40)		Difference Between Groups
	Mean	SD	Mean	SD	p-value	Mean	SD	Mean	SD	p-value
Age (years)	43.1	13.4	42.6	13.5	p=0.868	50.1	12.1	51.8	13.4	p=0.553
BMI	26.4	5.7	25.7	5.5	p=0.592	29.8	9.4	27.4	7.3	p=0.208
Years of wheelchair use	12.5	10.9	11.6	9.3	p=0.694	15.7	11.3	16.8	12.0	p=0.678
Age of Wheelchair	3.8	2.9	3.2	2.2	p=0.322	3.3	2.1	3.9	2.9	p=0.345
Demographics	**n**	**%**	**n**	**%**	**X^2, p-value**	**n**	**%**	**n**	**%**	**X^2, p-value**
Paraplegia	31	88.6%	29	90.6%	X^2=0.075, p=0.784	9	22.5%	13	32.5%	X^2=1.003, p=0.317
Less than 1 year since injury	1	2.9%	0	0.0%	X^2=0.928, p=0.335	3	7.5%	1	2.5%	X^2=1.053, p=0.305
Male	29	82.9%	25	78.1%	X^2=0.293, p=0.625	24	60.0%	27	67.5%	X^2=.487, p=0.485
Race					X^2=6.461, p=0.011 *					X^2=5.120, p=0.163
White	25	71%	13	46%		21	58%	17	45%	
Minority	7	20%	15	54%		15	42%	21	55%	
Missing	3	9%	4	13%		4	10%	2	5%	
Level of Education					X^2=1.275, p=0.529					X^2=0.618, p=0.734
High school or less	19	56%	16	52%		18	46%	21	53%	
2-4 years of college	12	35%	14	45%		15	39%	15	38%	
Graduate degree	3	9%	1	3%		6	15%	4	10%	
Missing	1	3%	1	3%		1	3%	0	0%	
Occupation					X^2=0.057, p=0.881					X^2=0.346, p=0.556
Working/ student/on the job training	10	29%	10	31%		6	15%	8	20%	
Retired/ homemaker/ unemployed/other	25	71%	22	69%		34	85%	32	80%	

*Indicates significant difference p<0.05