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Original Article

The Impact of Online Group Wheelchair Mobility and Transfer Training on the Performance of People with Spinal Cord Injuries: A Superiority Randomized Controlled Trial

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ABSTRACT

Background: Online training for the rehabilitation of people with spinal cord injuries (SCI) is essential. Various environmental barriers can make it challenging for individuals to attend face-to-face interventions. This study aimed to investigate the effectiveness of online group wheelchair mobility and transfer training on occupational performance and satisfaction in people with SCI.

Methods: In this single-blind randomized controlled trial, individuals with SCI were recruited from SCI association hospitals and clinics, and randomly assigned to an online training group (OTG) or a control group (CG) using blocked randomization. The OTG participated in five online training sessions over five weeks, while the CG received routine guidance via an individual online booklet. Outcomes were assessed post-intervention and at one-month follow-up immediately to evaluate changes in occupational performance and satisfaction. Treatment efficacy and between-group comparisons were analyzed using repeated measures analysis of variance (ANOVA).

Results: A total of 37 participants (CG = 18; OTG = 19) completed the 5-week intervention and follow-up assessments out of 49 enrolled. The mean age of participants was 35.0 years in the CG and 33.7 years in the OTG. Significant performance improvements ($p < 0.001$) and satisfaction ($p < 0.001$) were observed within the OTG during pre-post assessments. Additionally, significant differences between groups were found in both performance ($p = 0.026$) and satisfaction ($p = 0.015$).

Conclusion: The findings indicate that online wheelchair mobility and transfer training is an effective and feasible method for telerehabilitation in people with SCI.

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Introduction

A spinal cord injury (SCI) has profound adverse effects on multiple aspects of a person's life, disrupting normal functioning [1]. The global incidence of SCI is estimated to range from 10 to 21 cases per million people annually [2]. In Iran, according to the Spinal Cord Injury Research Center, approximately 1,411 to 2,011 new cases of SCI occur each year, predominantly affecting young individuals [3]. Because the spinal cord connects the brain to the rest of the body, any damage to it disrupts neural pathways, resulting in functional impairments and reduced performance [4]. For example, many people with SCI require full-time wheelchair use.

Although rehabilitation training is critical for promoting active, productive lives and improving functional performance in this population [5–7], only 40% of wheelchair users receive specialized training in wheelchair mobility and transfers [6]. Therefore, rehabilitation interventions are essential for individuals with SCI, as they can provide significant functional improvements [8,9] and support greater independence, activity, and participation in daily life [6,7].

Telerehabilitation is a reliable approach for the remote delivery of rehabilitation programs for people with SCI [10]. The use of remote methods for patient care has led to significant clinical improvements. Remote delivery was particularly essential during the COVID-19 pandemic, when in-person interventions were restricted due to preventive measures. These methods can provide a wide range of rehabilitation services, including assessment, intervention, prevention, monitoring, education, and counseling [11].

Because people with SCI often face challenges related to functional independence and access to healthcare [12,13], telemedicine provides a valuable opportunity to facilitate their engagement with the health system [14,15]. It is particularly beneficial for individuals who would otherwise be unable to access these services due to environmental barriers.

Previous studies have shown that remote interventions are both valuable and acceptable to people with SCI [16,17], with significant improvements in outcomes such as quality of life, mood, and functional performance [18]. This approach has also been shown to be cost-effective and can enhance the management of patients' conditions [18]. A systematic review indicated that outcomes of remote interventions are comparable to those of face-to-face interventions [19]. Similarly, occupational therapy literature has confirmed that in-person interventions and procedures delivered virtually or remotely yield equivalent outcomes [20].

With the increasing adoption of remote treatment approaches, the feasibility and utility of many specialized assessment tools have also been evaluated in remote settings [21]. Dreyer reported that the Canadian Occupational Performance Measure (COPM) is particularly suitable for occupational therapists and other professionals assessing telerehabilitation outcomes in adults, as it relies primarily on verbal responses rather than physical movement [21,22]. The COPM effectively evaluates both performance and satisfaction in individuals' daily activities.

According to Kirby, rehabilitation for people with SCI should prioritize training in wheelchair mobility skills and transfer techniques, given their significant impact on performance and efficiency in wheelchair use [23]. In the present study, the effects of training in transfer and mobility techniques were investigated. To our knowledge, the impact of distance-based training for wheelchair transfer and mobility skills on the performance and satisfaction of people with SCI has not been previously examined. Environmental barriers often make it challenging for individuals to leave home and participate in face-to-face interventions. Therefore, given the comparable effects of virtual and in-person interventions, this study aimed to investigate the effectiveness of online wheelchair mobility and transfer training on performance and satisfaction among individuals with SCI.

Materials and Methods

This study was a single-blind, randomized controlled trial, registered in the Iranian Registry of Clinical Trials (IRCT) under registration number IRCT20211220053459N1, and conducted in accordance with the CONSORT guidelines for clinical trials [24]. The study was approved by the Ethics Committee of Semnan University of Medical Sciences (approval number IR.SEMUMS.REC.1400.270). Before participation, all participants read and signed written informed consent forms.

Participants and Recruitment

Between February and May 2022, individuals with SCI were recruited through online advertisements and collaborations with hospitals and clinical centers in Semnan, in partnership with the Semnan Spinal Cord Injury Association. Inclusion criteria required participants to: Be 18 to 60 years old; Have paraplegic SCI; Not have previously participated in transfer techniques training or wheelchair mobility programs; Have used a manual or powered wheelchair at home or in the community within the last three months; Have internet access and be able to participate independently, and score above 23 on the Mini-Mental State Examination (MMSE) [25].

Participants who missed more than one session were excluded from the final analysis. Withdrawal from the study was permitted at any stage due to personal circumstances. Given the risk of falls during transfers, family members or caregivers were encouraged to attend the online intervention sessions. A preliminary online session was held to explain the study objectives and train caregivers on safety precautions.

Eligible participants were randomly assigned to either the online training group (OTG) or the control group (CG) using a blocked randomization method. Each block contained eight participants, with an equal distribution between groups. Randomization was performed by an investigator who was not involved in data collection to maintain blinding.

Outcome Measures

Assessments were conducted at baseline, immediately after the five-week intervention, and one month post-intervention by a trained assessor who was blinded to group allocation. The primary outcome measure was the Canadian Occupational Performance Measure (COPM), a validated, client-centered tool used to evaluate occupational performance and satisfaction across self-care, productivity, and leisure activities [22,28,29]. Participants identified up to five key problem areas, and scores were calculated as the mean performance and satisfaction ratings. The Persian version of the COPM has been validated for reliability in SCI populations [28,30].

A demographic questionnaire was used to collect data on age, gender, time, cause of injury, and wheelchair type. Although educational and employment status were also recorded, these variables were not analyzed in the present study.

Intervention Program

The intervention group (OTG) participated in a standardized wheelchair transfer training program based on Clinical Practice Guidelines (CPG) [26]. The program included: Transfer techniques (e.g., wheelchair to bed, chair, toilet, bathroom seat, car, floor, and vice versa); Wheelchair adjustments and mobility techniques (e.g., locking brakes, position changes); Proper body mechanics and safety guidelines; and Upper limb strengthening exercises to facilitate transfers.

Educational materials were provided online, including PowerPoint presentations and training videos developed in accordance with evidence-based clinical guidelines. The videos were reviewed by two experienced occupational therapists to ensure accuracy and were piloted with four participants with SCI to obtain feedback before finalization.

A trained occupational therapist conducted the OTG program over five weekly sessions, each lasting two hours, via the Skyroom web conferencing platform [27]. Sessions were held in small groups, during which participants accessed videos and slides and shared images. Each session concluded with a discussion that allowed participants to share challenges and experiences related to wheelchair mobility.

The control group (CG) received only a written booklet containing the same transfer-training content as the OTG, but without instructional videos. The booklet was delivered via email or WhatsApp.

Sample Size Calculation

The sample size was calculated based on the study by Daphne Kos, which reported an expected 2-point improvement in COPM scores post-intervention [31]. Assuming a standard deviation of 2.51, a correlation coefficient of 0.7, a power of 80%, and an alpha of 0.05, the required sample size was 22 participants per group. Accounting for an anticipated 20% dropout rate, the final target sample size was adjusted accordingly.

Data Analysis

Data were analyzed using SPSS version 20, with a significance level set at 0.05. Descriptive statistics, including means, standard deviations (SDs), frequencies, and percentages, were reported. Independent t-tests were used for continuous variables, and Chi-square tests were applied for categorical variables. The Shapiro–Wilk test confirmed the normality of the data ($p \geq 0.05$). To assess within- and between-group differences over time, a repeated-measures ANOVA (3 time points × 2 groups) was conducted to evaluate the effectiveness of the intervention.

Results

A total of 49 people with SCI completed baseline assessments and were randomized into the control group (CG, n = 24) or the online training group (OTG, n = 25). All participants provided written informed consent. Participants in both groups had similar injury levels (paraplegic) and were able to perform wheelchair push-up skills.

Of these participants, 42 completed the 5-week intervention (CG = 22, OTG = 20). Missing data due to attrition were treated as missing at random and excluded from the analysis. Three participants in the OTG dropped out after missing a single session, and two additional participants withdrew due to incomplete post-test assessments. In the CG, two participants withdrew because they did not complete the post-test (Figure 1). Ultimately, 37 participants (CG = 18, OTG = 19) completed the one-month follow-up assessments. No adverse events were reported during the study.

Subject characteristics are summarized in Table 1.

The mean age of participants was 35.0 years in the CG and 33.7 years in the OTG. There were no statistically significant differences between the groups in pre-test scores at baseline (Table 1). Other baseline characteristics of the participants are also summarized in Table 1.

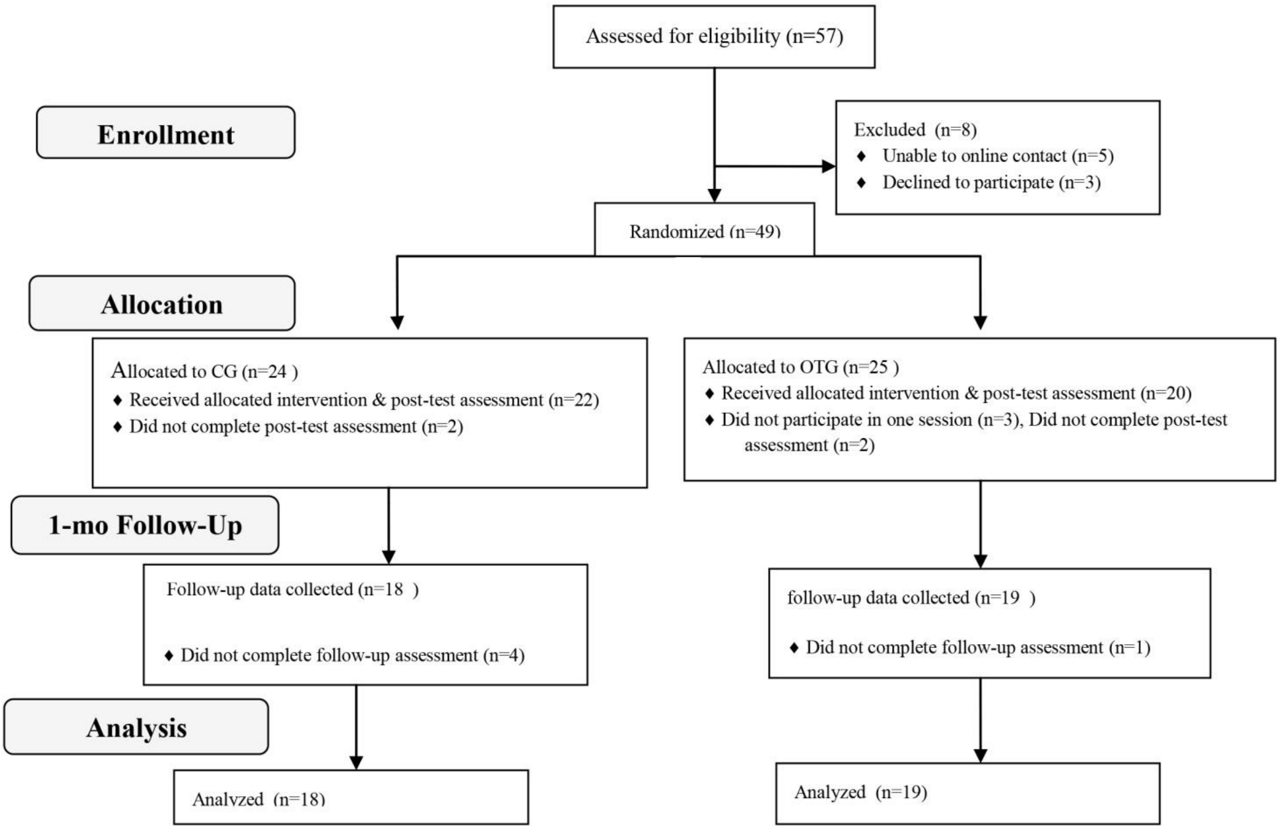

Figure 1: Flow Diagram of Participant Allocation (format from Schulz et al., 2010).

Table 1: Demographic characters of People with SCI

Variables	**CG (n=24)**			**OTG (n=25)**			***P* value**
	N (%)	**or**	**M (SD)**	**N (%)**	**or**	**M (SD)**	
Age			35.0(8.43)			33.7(8.54)	0.57*
Gender							0.47**
Women	10(41.7)			12(48)			
Men	14(58.3)			13(52)			
Type of wheelchair							<0.001**
Manual	23(95.8)			25(100)			
Power	1(4.2)			0			
Cause of injury							<0.001**
Vehicle accident	15(62.5)			11(44)			
Fall from height	3(12.5)			8(32)			
war injury	0			1(4)			
Spinal cord tumor	0			1(4)			
Other causes	6(25)			4(16)			
Time of injury	11.3(11.46)			6.4(5.51)			0.05*
COPM							
Performance	5.02(0.97)			4.80(1.36)			0.51*
Satisfaction	4.66(1.05)			4.56(1.40)			0.79*

*Independent *t*-test; **Chi-square test.

Given the small sample size, the Shapiro–Wilk test was used to assess the normality of performance and satisfaction scores; the results indicated that these scores were normally distributed. In the post-test assessment (n = 42), COPM scores increased by approximately 2 units, reflecting improvements in both performance and satisfaction in the OTG (Table 2). These improvements were maintained at the one-month follow-up (Table 2).

Within the OTG, there was a significant increase in performance (p < 0.001) and satisfaction (p < 0.001) from pre- to post-intervention (Table 3). The effect sizes, with 95% confidence intervals (CI), were 54.49 for performance and 33.89 for satisfaction based on pre–post changes (Table 3). Additionally, repeated-measures ANOVA confirmed significant between-group differences, with higher scores in the OTG than in the CG for both performance (p = 0.026) and satisfaction (p = 0.015).

Table 2: Mean [SD] of COPM scores before, after, and one month later of the intervention

Variables	Pretest (n=49) Mean (SD)	Posttest (n=42) Mean (SD)	Follow-up (n=37) Mean (SD)
COPM Performance			
OTG	4/80(1/36)	6/96(1/48)	6/53(1/85)
CG	5/02(0/97)	5/35(1/25)	4/93(1/39)
COPM Satisfaction			
OTG	4/56(1/40)	6/67(1/65)	6/23(1/85)
CG	4/66(1/05)	5/01(1/62)	4/52(1/37)

Note. COPM: Canadian Occupational Performance Measure

Table 3: Results of Repeated Measures Analysis of Variance

Outcome	F (df)	P
COPM Performance		
Time	54.49 (2)	<.001
Time * Group	5.40 (1)	.026
COPM Satisfaction		
Time	33.89 (2)	<.001
Time * Group	6.48 (1)	.015

Note. COPM: Canadian Occupational Performance Measure

Discussion

This study aimed to investigate the effect of online training in transfer techniques and wheelchair mobility on performance and satisfaction in people with SCI. The results indicated that both performance and satisfaction were significantly higher in the OTG than in the CG immediately after the intervention and at one-month follow-up. In contrast, there were no significant differences between groups at baseline.

In this study, the COPM was used to assess outcomes. Although there are SCI-specific measures of occupational performance, such as the Spinal Cord Independence Measure (SCIM), the COPM is an individualized, client-centered outcome measure that is particularly suitable for identifying personalized treatment goals—an aspect that other tools, such as the SCIM, cannot fully capture. Additionally, previous studies have demonstrated that the COPM is responsive to change over time and can reliably measure differences between pre-test and post-test scores [30].

According to the law, a change of more than 2 units in COPM scores indicates a clinically significant effect [29]. In the present study, COPM scores increased by approximately 2 points, demonstrating the sensitivity of this tool for assessing occupational performance in individuals with SCI.

Previously, Donnelly evaluated individuals with acute SCI using the COPM at the beginning of hospitalization and after discharge following in-hospital rehabilitation. Changes of 4 units were reported in performance and satisfaction scores, likely because participants were in the early stages of injury and initially had low functional levels [32]. Additionally, these participants had no prior educational or therapeutic experience.

In the current study, although participants were not in the acute stage of SCI, they had no history of prior educational program participation, which was an inclusion criterion. Participation in the online educational program, therefore, led to improvements in performance and satisfaction, as evidenced by significant changes in COPM scores. Johanson and Wangdell also reported changes exceeding 2 units in performance and satisfaction scores [33,34]. In their studies, the timing of evaluation and interventions immediately following surgery likely contributed to the observed changes [33,34].

In three other studies, the COPM was used as an outcome measure to assess occupational performance and satisfaction in people with SCI [35–37]. These studies reported changes of approximately 3 units in COPM scores. Developing individualized programs based on COPM results can lead to significant improvements in scores [35,36]. In the present study, however, the impact of a holistic online treatment approach was examined rather than individualized in-person interventions.

Based on a systematic review, 13 studies on telerehabilitation for people with SCI and other neurological injuries were analyzed, of which 10 focused exclusively on individuals with SCI [18]. These studies were heterogeneous in design and outcome measures, making comparisons difficult. In most studies, phones and computers were the primary technologies used to deliver interventions. In one study, the COPM was used as a secondary outcome measure [38] to examine the effect of interventions delivered via the Interactive Mobile Health and Rehabilitation (iMHere) system, which aimed to improve self-management skills. The impact of this web-based intervention on COPM scores was modest; however, in the intervention group, a slight improvement was observed after nine months of follow-up, whereas COPM scores in the control group decreased significantly over the same period. The intervention's limited focus on functional training may have affected the COPM outcomes. Nonetheless, the observed changes allowed participants in the intervention group to maintain their occupational performance over nine months.

Notably, this systematic review did not examine the effects of online transfer techniques and wheelchair mobility training on COPM scores [18]. Another systematic review conducted in low- and middle-income countries identified only five studies using remote rehabilitation approaches for people with SCI [39]. None of these studies assessed occupational performance or satisfaction. Methods of intervention delivery varied: in three studies, interventions were delivered through phone calls and follow-ups, and qualitative data suggested that remote rehabilitation could reduce social isolation and depression [39]. Most participants reported satisfaction with the intervention. In the remaining two studies, no quantitatively significant results were reported, and only two studies demonstrated improvements in outcomes such as quality of life, depression, pressure ulcer management, and functional abilities [39].

Limited interaction with patients, such as providing telephone-based interventions or sending images without simultaneous verbal and visual communication, may contribute to the lack of significant improvements in some outcomes reported in these studies. Evidence from remote rehabilitation approaches for people with SCI indicates that incorporating visual or video components enhances patient engagement and interaction during assessment and treatment [40,41]. While some studies have utilized telephone calls for initial evaluations [42–44], current evidence suggests that telephone communication is most appropriate when video calls are not feasible [45].

In the present study, participants received training through online classes that allowed for simultaneous verbal and visual communication. Educational content was provided as images and videos, which were shared individually with participants. Additionally, continuous individual feedback between sessions helped to maintain motivation and support adherence to the intervention [46].

One of the key strengths of this study was the implementation of a remote intervention. Challenges related to attendance—such as mobility limitations in people with SCI, environmental barriers affecting wheelchair access, and the need to coordinate schedules with caregivers—were effectively addressed through online program delivery.

However, several limitations should be acknowledged. A major limitation was the difficulty of selecting eligible participants based on online screening, which contributed to a relatively small sample size and may limit the generalizability of the findings. The restricted access to participants and the small population size, according to the inclusion criteria, also hindered the ability to differentiate between complete and incomplete injuries. Online studies require detailed, continuous monitoring to ensure that participants meet inclusion criteria, which can be challenging. Additionally, the final intervention session coincided with the Nowruz (the Persian New Year) holiday, resulting in a higher number of dropouts.

Given the wide age range in the inclusion criteria, the duration of injury may have influenced the results. Since this factor was not the focus of the present study, it was not investigated; future research is encouraged to examine the relationship between injury duration and intervention outcomes.

In the current study, people with SCI who had severe cognitive impairments were excluded. Future studies could explore the impact of online interventions on the burden on caregivers of people with SCI.

Finally, baseline information on the number of transfers participants had performed before the study was not collected. Including this information in future research could provide a useful reference point for comparing outcomes at the conclusion of the intervention and at the one-month follow-up.

Transfer ability is a critical skill for individuals with SCI, as it directly influences occupational performance and satisfaction. Therefore, therapists should incorporate transfer training into their intervention plans. The results from the online training format in this study demonstrated that participants with SCI were actively and effectively engaged in the intervention. Implementing online, or hybrid (in-person and online), interventions can improve accessibility, practicality, affordability, and convenience—particularly for patients with chronic or severe functional impairments who cannot attend in-person sessions.

Conclusion

Based on the findings of this study, remote interventions targeting transfer techniques and wheelchair mobility have a positive and lasting impact on the performance and satisfaction of people with SCI. Participants reported high satisfaction with the online program, as it circumvented functional and environmental barriers associated with motor impairments and limited access to training facilities. Although some participants faced challenges accessing digital platforms or the Internet, the results indicate that online and remote interventions are practical and effective for the rehabilitation and training of people with SCI.

Authors' Contribution

SH.P and F.M. conceptualized the study, developed the methodology, re-analyzed clinical and statistical data, and revised the manuscript. F.H. collected clinical data and prepared the manuscript. Y.S. analyzed and interpreted the data. M.M. participated in the implementation of the intervention. All authors read and approved the final manuscript.

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Conflict of Interest: The authors declare no conflicts of interest.

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