Effectiveness of online wheelchair mobility and transfer training on the occupational performance in people with spinal cord injuries

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Article

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Abstract

Background

Online training for the rehabilitation of People with Spinal Cord injuries (PwSCI) is necessary. Various environmental barriers create challenges in transferring and transporting these individuals out of the home to participate in face-to-face interventions. Furthermore, these challenges were exacerbated by the COVID-19 pandemic in the past.

Study Design:

A single-blind randomized controlled trial.

Objectives

This research aims to investigate the effectiveness of online wheelchair mobility and transfer training, on the level of performance and satisfaction in PwSCI.

Setting:

SCI associations and hospitals and clinical centers.

Methods

The PwSCI were randomly divided into an online training group (OTG) and a control group (CG). The OTG received online training during 5 group sessions for five weeks. The results were analyzed to compare changes in occupational performance level and satisfaction after the intervention, and one month later.

Results

37 (CG = 18 and OTG = 19) out of 49 participants completed the 5-week intervention and follow-up assessments. The average age of participants in the CG was 35.0 years, and the OTG was 33.7 years. We found a significant increase in performance (p < 0.001) and satisfaction (p < 0.001) within the OTG during the pre-post assessment. There were also significant differences in performance (p < 0.026) and satisfaction (p < 0.015) between groups.

Conclusion

The results showed that online wheelchair mobility and transfer training can be a suitable method for telerehabilitation and training PwSCI.

Introduction

A spinal cord injury (SCI) is an injury that has many adverse effects on all aspects of a person's life and disrupts the normal process of life [1]. The average worldwide incidence of SCI is between 10 to 21
persons per one million people [2]. Still, in Iran, according to the Spinal Cord Injury Research Center, the number of people with SCI (PwSCI) is 1411 to 2011 per year, with SCI mainly occurring in young people [3]. Since the spinal cord is responsible for the connection between the brain and other parts of the body, any damage to the spinal cord disrupts the neural pathways and causes disability in the function and performance of the person [4]. For instance, some PwSCI need to use a wheelchair full time. Although rehabilitation training is a key factor for an active and productive life, and improving the level of performance in these people [5–7], only 40% of wheelchair users receive specialized wheelchair mobility and transfer training [6]. Therefore, rehabilitation is a necessary intervention in the rehabilitation of PwSCI and can provide significant functional improvement in PwSCI [8, 9]. It is also a key factor in an active and productive life and improving the level of performance of these people [6, 7].

Telerehabilitation is a reliable approach for the remote delivery of rehabilitation programs for PwSCI [10]. The use of remote methods for treating patients has seen important clinical improvements. Remote delivery was especially essential during the COVID-19 pandemic, as in-person interventions were contrary to preventative procedures. These methods can provide various rehabilitation services such as assessment, intervention, prevention, monitoring, education, and counselling [11]. Since PwSCI faces many challenges in functional independence and accessibility to healthcare [12, 13], telemedicine approaches provide a unique opportunity for these people to access the health system [14, 15]. It is beneficial for a group of these people who are denied access to these facilities, due to environmental barriers.

Previous studies have shown that remote interventions have been valuable and satisfactory in PwSCI [16, 17], and a significant improvement in outcomes such as quality of life, mood and function has been reported [18]. Using this approach has been reported to be cost-effective and can improve the management of the patient's condition [18]. The results of a systematic review mentioned that the outcomes of remote interventions are similar to face-to-face interventions [19]. Occupational therapy literature also confirmed that in-person interventions and procedures presented in a virtual or remote environment had identical outcomes [20]. With the expansion of remote treatment approaches, the applicability and implementation of many specialized questionnaires were also examined and investigated remotely [21]. Dreyer expressed that the Canadian Occupational Performance Measurement (COPM) is an appropriate tool for occupational therapists and other professionals to assess telerehabilitation outcomes in adults because it relies on verbal responses rather than physical movement [21, 22]. This tool can analyze the level of performance and satisfaction in people's daily life activities.

According to Kirby's suggestion, the rehabilitation of PwSCI is necessary to focus on the training of wheelchair mobility skills and transfer techniques, due to its significant impact on the performance and efficiency of wheelchair use [23]. In the present study, the effect of training transfer and mobility techniques were investigated. Based on our knowledge, the impact of distance training in wheelchair transfer and mobility techniques on the level of performance and satisfaction of PwSCI has not been studied. Notably, environmental barriers create challenges in transferring and transporting these individuals out of the home to participate in face-to-face interventions. Furthermore, these challenges
were added to the COVID-19 pandemic. Therefore, considering the similar effects of virtual and face-to-face interventions, the purpose of this research was to investigate the effectiveness of online wheelchair mobility and transfer training on the level of performance and satisfaction in PwSCI.

Methods

This study was a single-blind randomized control trial registered in the Iranian Registry of Clinical Trials (http://www.irct.ir) with the number IRCT20211220053459N1 and followed a reporting guideline based on the CONSORT [24]. The Semnan University of Medical Sciences Ethics Committee approved this study with the number IR.SEMUMS.REC.1400.270.

PwSCI were recruited for this clinical trial between February and May 2022. Recruitment was done through the registered information in spinal cord injury associations and hospitals and clinical centers via online advertisements. The inclusion criteria included individuals between the ages of 18 to 60 years; Paraplegic type of SCI; Have not participated in a transfer techniques training and wheelchair mobility program before; Used the wheelchair (power or manual) at home or in community in the last three months; Possible access and use of a smart system and internet; The ability and adequate time to participate in the intervention program independently; and obtaining a score higher than 23 on the MMSE cognitive test [25]. Participants who were absent in more than one session were excluded from the study analysis. In addition, participants were free to opt out of the study at any stage of the research, depending on their conditions.

Over the phone, the research goals were explained to the PwSCI who met the inclusion criteria. Then, the consent form was sent via SMS, email, or WhatsApp. Interested participants completed the form and returned it to the researcher. Based on Fig. 1, 37 eligible individuals with SCI completed intervention sessions and follow-up assessments in the present study [24]. Then, the participants were randomly divided into one of the two intervention or control groups respectively, and the blocked randomization method was generated by an investigator who was not involved in data collection. The size of the blocks was equal. Blocks of eight were considered, which included four participants in the intervention group and four in the control group. Assessments were conducted at the beginning, after 5 weeks, and one month later by a trained assessor who was blinded to the online training group (OTG) and the control group (CG). The demographic questionnaires and the COPM were prepared online and provided to the participants. The questionnaire link was sent to the PwSCI through SMS, email, or WhatsApp. In addition to sending online links, COPM was recorded via phone call to ensure the correct answers. The assessor was trained to administer the COPM in a 90-minute session.

The training in the OTG was the standardized transfer exercise program based on a clinical practice guideline (CPG) [26] and included: 1. All transfer techniques from wheelchair to bed, chair, toilet or bathroom seat, car, floor and vice versa; 2. The principles of adjusting all types of wheelchairs and wheelchair mobility techniques such as locking the brake, and changing the position in the wheelchair; 3.
Guidelines and Tips for Using Proper Body Mechanics; 4. Upper limb strengthening exercises to carry out transfers were based on the Clinical Practice Guide (CPG) [26].

The educational materials were prepared online in the form of PowerPoint and training videos. During a 4-hour session, an occupational therapist acquired the necessary training and sufficient skills to teach the participants in the intervention group. The trained occupational therapist conducted an OTG program during 5 group sessions for five weeks on the Skyroom, and a two-hour session was held every week. Skyroom is a web conferencing service. It easily creates meetings or webinars with thousands of participants and enables desktop sharing, audio-video communication, slideshow, dashboard, and audio-video file sharing [27]. The participants in OTG were trained in two smaller groups and had access to PowerPoint slides, videos, and shared photos. At the end of each session, the participants discussed their challenges related to the issue and shared their experiences. The control group received routine related to transfer and mobility principles and essential counseling, in a format of an online booklet via email, or WhatsApp.

The outcome measure was the comparison of changes in occupational performance level and satisfaction after the intervention and one month later based on Canadian Occupational Performance Measure (COPM) scores between CG and OTG. The COPM is a unique, client-centred, individualized outcome measure to allow the clients to rate their perception of occupational performance level and satisfaction with their performance in self-care, productivity, and leisure. It is conducted as a semi-structured interview, and the client was asked to rate their current performance and satisfaction in the 5 paramount important problems. The total scores in each section are obtained as follows: Total performance or satisfaction scores are divided by the number of problems, and total performance or satisfaction scores are obtained. The COPM was developed by Law for the first time and its test-retest reliability and validity were acceptable and desirable [22, 28, 29]. A previous study has also shown that the COPM is a reliable tool for evaluating the performance of daily activities and satisfaction with PwSCI's performance [30].

In addition, participants completed a demographic questionnaire consisting of information on age, gender, time and cause of injury, and type of wheelchair. Some socio-demographic information of participants such as education or employment was recorded but the present study did not analyze it.

The sample size was obtained based on the results of Daphne Kos's study for an estimated difference of 2 units of change in the COPM tool after the intervention [31]. Therefore, with a standard deviation of 2.51 and correlation coefficient of 0.7 with a power of 80% and alpha of 0.05, according to the formula

\[ n = \frac{4(Z_1-Z_2)^2?(1-r)}{[(\bar{X}_1-\bar{X}_2)/SD]^2} \]

and considering the 20% probability of dropout during follow-up, 22 subjects were needed in each group.

Data were analyzed using SPSS version 20 software, and the significance level considered was 0.05. Descriptive statistics, central tendency, and dispersion indices were used. For quantitative data analysis, the mean and standard deviation and the qualitative data, frequency, and percentage were used.
Independent t-tests for continuous variables and Chi-square for categorical variables were used for group differences. The normal distribution of the data was assessed by the Shapiro-Wilk Test (p ≥ 0.05). In addition, to determine the efficacy of treatment and compare the results in each group (3 times x 2 groups), the repeated measures analysis of variance (ANOVA) was used.

Results

49 PwSCI completed the baseline assessments and 24 were randomized into the CG, and 25 into OTG. All participants provided written informed consent. Participants in both groups had a similar range of injury levels (paraplegic) and could perform a push-up skill. Of these participants, 42 completed the 5-week intervention (CG = 22, OTG = 20). The missing data mechanism due to attrition in this study was at random and was ignored for analysis. 3 participants dropped out during the OTG due to not participating in one session, and 2 withdrew because they did not complete the post-test. Moreover, 2 participants withdrew from the CG because they did not complete the post-test (Fig. 1). Finally, 37 participants (CG = 18, OTG = 19) completed one-month follow-up assessments. No adverse events occurred during the study implementation. Subject characteristics are presented in Table 1.

The average age of participants in the CG was 35.0 years, and the OTG was 33.7 years. There was no statistically significant difference in the pre-test mean values between CG and OTG at the baseline (Table 1). The other baseline characteristics of participants are presented in Table 1.
Table 1
Demographic characters of PwSCI

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

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

Due to the small sample size, the Shapiro-Wilk test was used to measure the normal distribution of performance level and satisfaction scores, so the results showed these scores have a normal distribution. There were about 2 units of change in the COPM scores in the post-test assessment (n = 42), so the scores indicated an increase in performance and satisfaction (Table 2) in OTG. These changes continued for one-month following the intervention (Table 2).

In the post-test assessment (n = 42) we found a significant increase in performance (p < 0.001) and satisfaction (p < 0.001) within OTG (Table 3). The effect sizes with 95% confidence interval (CI) based on the changes in the pre–post-assessment was 54.49 and 33.89 for the performance and the satisfaction,
respectively. (Table 3). In addition, the results of the ANOVA test, based on Table 3 confirmed a significant
difference between the two groups in terms of 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

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

Note. COPM: Canadian Occupational Performance Measure

### Table 3
Results of Repeated Measures Analysis of Variance

<table>
<thead>
<tr>
<th>Outcome</th>
<th>F (df)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPM Performance</td>
<td>54.49 (2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time</td>
<td>5.40 (1)</td>
<td>.026</td>
</tr>
<tr>
<td>Time * Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPM Satisfaction</td>
<td>33.89 (2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time</td>
<td>6.48 (1)</td>
<td>.015</td>
</tr>
<tr>
<td>Time * Group</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. COPM: Canadian Occupational Performance Measure

< Insert Table 2 here>

< Insert Table 3 here>

**Discussion**

This study aimed to investigate the effect of online training in transfer techniques and wheelchair mobility on the level of performance and satisfaction in PwSCI. Based on the results, the level of
performance and satisfaction in the two groups showed a significant difference after the intervention and one month later. There was no significant difference between these scores between the two groups in the baseline. In the present study, we have been using COPM, although there are SCI-specific measures of occupational performance that may suit this population, such as the Spinal Cord Independence Measure (SCIM). However, the COPM is an individualized, client-centred outcome measure and is appropriate to identify treatment goals, while other tools such as the SCIM are not able to do so. In addition, previous studies have demonstrated that COPM responds to changes over time and measures changes between pre-test and post-test scores [30].

According to Law’s report, a change of more than 2 units in COPM scores indicates clinically significant effects [29]. The scores of COPM in the current study have shown a change of 2 units, demonstrating the sensitivity of this tool in examining the occupational performance of PwSCI. In the past, Donnelly (2004) evaluated people with acute spinal cord injury with COPM at the beginning of hospitalization and after discharge (received rehabilitation in the hospital). Donnelly reported changes of 4 units in performance and satisfaction scores because the patients were in the early stages of the injury and initially had low functional levels [32]. Furthermore, participants did not have any previous educational and therapeutic experience. In the present study, although the participants were not in the early stages of acute spinal cord injuries, they lacked a history of participation in previous educational programs, which was considered in the entry criteria. Thus, participation in an online educational program was able to improve their performance and satisfaction as shown through the significant changes in their scores. Johanson and Wangdell also reported a change of over 2 units in the performance and satisfaction scores on this scale [33, 34]. In these studies, the evaluation time and the interventions followed immediately after the surgery could be the reason for the change in the COPM scores [33, 34]. In three other studies, COPM has been used as an outcome measure to evaluate occupational performance and satisfaction in PwSCI [35–37]. In these studies, the change in scores of the COPM was reported at about 3 units of change. Developing an individual program based on the results of the COPM can cause significant changes in COPM scores [35, 36]. However, in the present study, the effect of a holistic online treatment approach was investigated.

Based on a systematic review (2021), 13 studies were reviewed on telerehabilitation in PwSCI and other neurological injuries, of which 10 studies focused exclusively on PwSCI [18]. All these studies were heterogeneous in terms of study design and used outcome measures, making comparison difficult. In most of these studies, phones and computers were the more common technologies used to deliver the intervention. In one of the studies, COPM was used as a secondary outcome measure [38], and the effect of interventions based on The Interactive Mobile Health and Rehabilitation (iMHere) system aimed at improving self-management skills. The results of this web-based internet communication intervention on COPM scores were weak. However, in the intervention group, after nine months of follow-up, a slight improvement was achieved, and in the control group, the COPM scores decreased significantly during this period. It seems that the lack of focus on functional training affecting the occupational performance of patients in the intervention program affected the scores of this scale. In any case, this change in scores helped the participants in the intervention group to find out that they could maintain their level of
performance for nine months. In the systematic review (2021), the effect of online transfer techniques and wheelchair mobility training on changing COPM scores was not studied [18]. In another systematic review conducted in 2022 in low- and middle-income countries, only 5 studies used the remote rehabilitation approaches in PwSCI [39]. None of them investigated the level of occupational performance and satisfaction. The methods of providing interventions were different in these studies. In 3 studies, interventions were provided through phone calls and follow-ups. The qualitative data indicated that remote rehabilitation could reduce patients' social isolation and depression [39]. Most participants were satisfied with the implementation of the intervention program [39]. In 2 studies, quantitatively significant results were not reported. Only 2 studies mentioned significant improvements in some outcomes, such as quality of life, depression, management of pressure ulcers, and functional abilities [39].

Since there is not much interaction with patients in providing telephone interventions or simply sending images without simultaneous verbal and visual communication, this issue can be effective in the lack of significant improvement in some of the outcomes of these studies. The evidence related to the use of remote rehabilitation approaches in PwSCI showed that better interaction with patients in the assessment and treatment process occurs when visual or video components are included in the delivery of treatment programs [40, 41]. Although some studies have used telephone calls for initial evaluations [42, 43], evidence suggests that telephone communication is best used when video calls are impossible [44]. In the present study, patients trained through online classes and benefited from the possibility of simultaneous verbal and visual communication, as educational content was prepared in the form of images and videos and sent to the participants individually. Moreover, individual and continuous feedback in the intervals between intervention sessions helps improve the motivation level for continuing participation [45].

**Strengths, limitations, and Suggestions**

The most important strength of this research was the implementation of remote intervention. Attendance challenges caused by mobility limitations of PwSCI, environmental barriers regarding mobility with a wheelchair, and the necessity to coordinate a time with the caregivers to attend PwSCI in the treatment centers were resolved by the remote implementation of the program.

There were some limitations in the present study that should be mentioned. One of the main limitations of the present study was the difficulty in selecting eligible participants based on entry criteria online. One of the problems of sampling in studies where all steps are done online is the need for a more detailed and continuous check for the participant's compliance with the inclusion criteria. In addition, the last patient's intervention session coincided with the Nowruz (New Year's) holiday, resulting in many dropouts.

Due to the wide age range in the inclusion criteria of the present study, the duration of injury could have affected the results, and considering that it was not the aim of the present study and was not investigated, it is suggested that in the future, this issue and the relationship should be studied. In the current study, PwSCI who had severe cognitive problems were excluded. It is suggested that training and
treatment recommendations be carried out on these people with a focus on the training of their caregivers, and the effect of the online intervention on the caregivers of PwSCI was not investigated. It is suggested that the possible effects of the implementation of these educational and therapeutic programs on the caregivers of these individuals should also be explored in future research.

Finally, in this study, information regarding the baseline level of transfers being performed before the study was not provided. This information could be beneficial to compare results at the end of the study, and at a one-month follow-up.

**Implications for Research and Practice**

The transfer is an essential component of PwSCI that increases the patient’s occupational performance and satisfaction level. Therefore, therapists should include transfer training in their intervention plans. The results obtained from the online training format of transfer techniques in this study showed that the PwSCI were optimally engaged in the intervention. The implementation of online or a combination of in-person and online interventions, in patients with chronic and severe functional injuries who cannot participate in the interventions in person, can be more accessible, practical, affordable, and convenient in terms of time.

**Conclusion**

Based on the findings of this study, remote interventions of transfer techniques and wheelchair mobility have a positive and lasting effect on the performance and satisfaction of people with spinal cord injuries. All the participants were satisfied with the online implementation of the program as it bypasses the ensuing functional and environmental challenges caused by motor disabilities and the inability to attend training programs. Although it was difficult for some patients to access the smart system and the Internet, the final results showed that online and remote users could be a suitable and practical method for rehabilitating and training people with SCI.

**Declarations**

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**Conflict of Interest**

The authors have no conflict of interest.
Authors' Contribution

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

References


Figure 1

Flow diagram of participant allocation (format from Schulz et al., 2010).