https://doi.org/10.48047/AFJBS.6.10.2024.7463-7471

THE EFFICACY OF TELEREHABILITATION-BASED TASK-SPECIFIC TRAINING FOR COGNITIVE FUNCTION IMPROVEMENT IN MULTIPLE SCLEROSIS (MS) PATIENTS

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Article History
Volume 6 issue 10, 2024
Received: 20 May 2024
Accepted: 25 June 2024
doi:
10.48047/AFJBS.6.10.2024.7463-7471

ABSTRACT

Introduction
Cognitive impairment in multiple sclerosis (MS) can present as deficiencies in the speed at which information is processed, memory, the ability to plan and execute tasks (executive function), and attention. To investigate the potential impact of tele-rehabilitation-based task-specific training on cognitive function improvement in patients with Multiple Sclerosis (MS).

Method
The study design was an 8-week double-masked, randomized controlled trial involving 52 participants, who were randomly split into two groups. Specifically, Group A had telerehabilitation cognitive training through Physitrack processing speed exercises. The control Group B was given traditional CR intervention. Both groups sought to improve cognitive function and quality of life in MS patients through MoCA and MSIS assessment.

Results
Group A, with a mean age of 38±6.67 and Group B, which had a mean age of 30.96±6.61. They never had the technology, and they survived single. At baseline and in the 8th week, Group A had significantly higher scores on the MOCA compared to Group B; however, there was no significant difference between the two groups in the MSIS scores.

Conclusion
This study concluded that telerehabilitation group A had higher cognitive function than group B, which underwent traditional cognitive rehabilitation intervention.

Key Words: Cognitive Function, Multiple Sclerosis, Neuro-rehabilitation, Task-Specific Training, Telerehabilitation, Quality of Life

INTRODUCTION

Multiple sclerosis (MS) is a chronic inflammatory disorder affecting the central nervous system (CNS), which leads to the deterioration of myelin sheaths and axons. The condition presents a range of symptoms encompassing motor, sensory, cognitive, and visual deficits. (Dobson & Giovannoni, 2019) Cognitive impairment is a prevalent and significant symptom of multiple sclerosis (MS), impacting as many as 70% of individuals with the condition. Cognitive impairment in multiple sclerosis (MS) can present as deficiencies in the speed at which information is processed, memory, the ability to plan and execute tasks (executive function), and attention. (McGinley et al., 2021) The prevalence rates for MS were 159 and 418 per 100,000 individuals for each sex, respectively. The study revealed that there were 2.6 times more women with MS than males. (Gilmour et al., 2018a, 2018b)

The impact of multiple sclerosis (MS) encompassed several functional impairments, including pain, mobility, mood or sleep disturbances, and limits in social engagement. (Zhang et al., 2021) There are two primary categories of psychotherapies: pharmacologic treatments (such as disease-modifying medicines and therapeutic therapy) and non-pharmacologic methods that aim to rehabilitate both mental and physical aspects. Several studies have demonstrated a correlation between physical exercise and cognitive performance. (Miller et al., 2018) Cognitive rehabilitation, which focuses on training in specific cognitive abilities, has shown promise as an intervention to enhance cognitive function in individuals with multiple sclerosis. (Goverover et al., 2018) Conventional psychotherapy methods often entail an in-person session with a qualified therapist.(Irvine et al., 2020)

Self-selected physical activity in persons with MS can promote physical function, decrease fatigue, and increase mood. (Pilotto et al., 2024) The QOL in multiple sclerosis (MS) depicts the differences between face-to-face rehabilitation and clinical rehabilitation settings. Hence, it is possible for every person to enhance QOL, and as such, it can only be delivered individually. (Remy et al., 2020) Tele-rehabilitation could be performed or delivered through video and computer-supported teleconferencing or through programmers and applications of a special design or download on smartphones. This makes it easy for a patient to be supervised continuously because they can easily access the treatment in the comfort of their home. (Maresca et al., 2020) It also helps enhance Cognitive rehabilitation (CR) therapy services, enhances patient compliance and interactivity, and lowers healthcare expenses. (Schröder et al., 2019) Task-specific training is one type of rehabilitation that involves imitating meaningful tasks to train certain tasks. One such empowerment that can be unique is the delivery of job-related training in combination with the use of telemedicine for Multiple Sclerosis. (Robinson et al., 2019) This training occurs in their comfort zones, which are homes, without making demands that can overstrain them. Much about CI in MS and its implications are still unknown today, although research studies have established that it exists and can be treated with CR effectively. (Chapman, 2022)

Most TST therapies target certain cognitive processes underlying functioning within a given environment, so they can be fine-tuned, if necessary, by addressing the requirements of the specific patient. (Nabizadeh et al., 2022) The purpose of this study was to assess the impact of telerehabilitation-based task-specific training on improving cognitive outlook in multiple sclerosis (MS) patients. In essence, telerehabilitation resorts to technology to offer cognitive

training from a distance, making it a solution to the problems faced by people with mobility issues. This locally based strategy was beneficial for owners of severe mobility requirements as it provided better and easier availability. Furthermore, patients' perceived effects on their quality of life were other evaluation objectives.

METHODOLOGY

It was a randomized controlled trial approved by the IRB committee (FAHS/DPTRS/2/24/MS/RS-3405) was set to investigate the efficacy of a psychological rehabilitation intervention among Relapsing-Remitting Multiple Sclerosis (RRMS) persons. The population of this study was comprised of all the patients of District Head Quarters Hospital Narowal, Khalid Eye, and Medical Care Lahore, for which convenience sampling was adopted. Hence, since the study planned to have two groups, one experimental group and one control group, with 26 students each, a total of 52 students were computed using G * Power. The inclusion criteria of participants supported the selection process since it helped to make sure that all the participants in the study had been diagnosed with the ailment by a neurologist; the participants had to be between 20 and 45 years of age with a diagnosis of multiple sclerosis of between one and three years. The presence of psychosis is confirmed by standardized psychometric testing. A stable treatment environment that allows intervention. Internet access with camera and computer/tablet. Hence, the exclusion criteria included a history or current diagnosis of any type of severe psychiatric disorder, any other types of psychological treatment, or current clinically unstable medical conditions. Recruitment and data collection comprised the use of a screening test for the patient's cognitive status using the Montreal Cognitive Assessment (MoCA) and the self-report Multiple Sclerosis Impact Scale (MSIS-29). Participants were grouped into the different interventions. The physiotherapists were blind, and this minimized bias in the determination of the status of the patients. The research adhered to ethical standards, maintaining participant confidentiality and compliance with regulatory requirements (Clinical trial registration number NCT06428201)

Intervention

After careful assessment and evaluation, participants were randomly assigned to two groups. Group A, also known as the Experimental group, has developed a telerehabilitation program that focuses on task-specific training to increase intellectual capacity. Group B (Control) received standard therapy, including in-clinic cognitive rehabilitation sessions.

Telerehabilitation

The intervention group of the patients underwent an 8-week cognitive telerehabilitation program with 20-30 minutes from the Physitrack app twice a week with the help of personal computers or phones. This technology used to overcome anxiety was first created during the first session at the clinic. The elements of the program covered organized cognitive tasks focusing on memory, attention, executive function, and processing speed, and before every cognitive task, the relaxing tasks such as envisioning a beach environment. Specific, written training sessions, according to the results of the assessments, were conducted for participants; no distractions were allowed. Auditory and haptic inputs were applied to encourage clients, and the task difficulty appeared to escalate depending on the participants' performance. For instance, the walking surfaces were made to become unstable or, at times, up and inclined as the participants advanced. The program showed real-life appositeness of remote cognitive therapy for MS control; it improved therapists'

compliance and delivered feedback via telerehabilitation equitably. (Kahraman et al., 2020)

Clinical Rehabilitation

This training was a sixty-minute session, and psychotherapy exercises were carried out twice a week for eight weeks in a clinical setting equipped with training tools. PTs made it a point that the instructions given to the clients were very clear and concise. Memory training was comprised of story recall and paired associate learning with spatial memory. Stroop tasks and visual search tasks were used for attention training, while EF training involved problem-solving, planning, and working memory training. The objective was to improve the executive processes that are central to MS rehabilitation. **(Jahn et al., 2021)**

Data Analysis

Descriptive statistics, including categorical frequency bar charts, were used to describe the participant demographics, whereas bar chart graphs were used to present frequencies of categorical variables. As for the measurement data, histograms were employed to display the distribution of continuous variables because the collected data did not have a normal distribution. To compare the subjects' within-group cognitive function score data, the Wilcoxon signed rank test was employed due to its applicability in non-parametric data situations. Due to the lack of normality in the variables being assessed, other tests, such as the Mann-Whitney U test, were applied to the between-group comparisons of the cognitive function measures.

RESULTS

Table 1 shows demographic characteristics and patient responses for Multiple sclerosis treatment groups. Group A (n=26) and Group B (n=26). Independent mobility was revealed in 15% of Group A against none in Group B, technology access was in 27% of Group A against none in Group B, high secondary education was 31% in Group A, and only 12% in Group B, and more individuals were living alone were reported in 27% in Group B as compared to only 4% in Group A (Table 2).

The mean age of participants in Group A was 32.38±6.67, while in Group B, it was slightly lower at 30.96±6.61. It was found that at the baseline, the MOCA score was higher in Group A, which was 21.03 ± 2.84, and at the end of the therapy in the eighth week, it was 23.92 ± 3.34, respectively, but MSIS was non-significant between the two groups shown in Table 3. Altogether, it indicates that the results of the Wilcoxon tests reveal the changes in MOCA and MSIS scores before and after the intervention within the groups (Table 4). This study also revealed differences in the MOCA scores through the Mann-Whitney U test, which presented results where Group A obtained a significantly higher score (Table 5)

TABLES

Table *1*: Frequency/Percentage of Qualitative Demographic

Variable	Construct	Group A		Group B	
		Frequency	%	Frequency	%
Gender	Male	16	61.5	16	61.5
	Female	10	38.5	10	38.5
Education Level	No formal education	9	34.6	5	19.2
	Primary school	4	15.4	7	26.9
	Secondary school	8	30.8	3	11.5
	College/University	5	19.2	11	42.3
Mobility Status	Fully ambulatory	4	15.4	0	0.0
	Ambulatory with assistance	11	42.3	10	38.5
	Wheelchair-bound	4	15.4	11	42.3
	Bed-bound	7	26.9	5	19.2
Living Situation	Living alone	1	3.8	7	26.9
	Living with family	20	76.9	12	46.2
	Living with caregivers	5	19.2	7	26.9
Access to Technology	None	0	0.00	100	100.0
	Personal computer	13	50.0	0	0.00
	Smartphone	7	26.9	0	0.00
	Tablet	6	23.1	0	0.00
Previous Experience with Rehabilitation	None	17	65.4	23	88.5
	Tele-Rehabilitation	0	0.00	0	0.00
	In-person rehabilitation	8	30.8	3	11.5
	Both in-person and telerehabilitation	1	3.8	0	0.00
Comfort with Technology	None	0	0.00	26	100.0
	Comfortable	14	53.8	0	0.00
	Neutral	6	23.1	0	0.00
	Uncomfortable	4	15.4	0	0.00
	Very uncomfortable	2	7.7	0	0.00
Preferred Method of Communication	None	0	0.00	26	100.0
	Video call	17	65.4	0	0.00
	Phone call	4	15.4	0	0.00
	Email	1	3.8	0	0.00
	Text message	4	15.4	0	0.00

Table 2: Descriptive Statistics of Montreal Cognitive Assessment (MOCA) and Multiple Sclerosis Impact Scale (MSIS)

Variable	Group A		Group B	
	Mean	**SD**	**Mean**	**SD**
Age	32.38	6.67	30.96	6.61
MOCA at Baseline	21.03	2.84	3.80	1.13
MOCA at 8th Week	23.92	3.34	18.38	3.75
MSIS at Baseline	28.4	5.6	27.9	4.8
MSIS at 8th Week	25.9	4.9	26.5	5.2

Table 3: Wilcoxon Signed Rank Test (Within Group Analysis)

		Mean Rank	**Sum of Ranks**	**z value**	**p-value**
MOCA(baseline-4th weeks)	Negative Ranks	13.00	52.00	-5.731	0.049
	Positive Ranks	27.11	1274.00		
MSIS (baseline - 4th weeks)	Negative Ranks	20.3	406	-2.1	0.035
	Positive Ranks	30.7	614		

Table 4: Mann Whitney U Test (Between Group Analysis)

Variables	Treatment Groups	Mean Rank	Sum of Ranks	Mann Whitney U test value	P Value
MOCA at Baseline	Group A	39.50	1027.00	140	0.123
	Group B	13.50	351.00		
MOCA at 8th Week	Group A	35.96	935.00	92.0	0.045
	Group B	17.04	443.00		
MSIS at Baseline	Group A	19.90	418.90	200.5	0.068
	Group B	23.10	484.10		
MSIS at 8th Week	Group A	21.00	441.00	150.5	0.001
	Group B	25.70	538.70		

DISCUSSION

Data showed positive changes in the cognitive function of Group A engaged in telerehabilitation compared to Group B. The positive impact of telerehabilitation in multiple sclerosis patients was discovered by comparing Group A, who underwent telerehabilitation, and Group B, who didn't. This fact validates the possibility of telerehabilitation in reaching the cognitive areas that MS compromises.

Turhan K. et al. conducted the study in Turkey in 2022 and compared groups of participants according to several demographic indicators. The Tele rehab group 1 included the majority

(80%) females (70%) of them had a university education, and the majority of them (65%) were married. Group 2 (In-person treatment) comprised 93.3% of females and the highest percentage of individuals with a university education, 86.7%.(Kahraman et al., 2020). In Group A, the participants' mean age was 32. 38±6. 67, while in Group B, it was 30. 96±6. 61. Among Group A (n=26), 30% had completed their secondary education. 8%, while the average of Group B patients was. 11%. 5 percent have higher education as compared to the national average. The gender prevalence was 615% males in both groups.

Only a limited number of research have investigated the use of home-based cognitive training activities in individuals with multiple sclerosis. (Charvet et al., 2017; Di Tella et al., 2020) Blair et al. 2021 conducted a pilot study receiving adaptive cognitive remediation that demonstrated significant improvements in information processing speed, as measured by the Symbol Digit Modalities Test (SDMT), and visual memory, assessed through the Brief Visuospatial Memory Test-Revised (BVMT-R). These findings underscore the efficacy of tailored cognitive interventions in enhancing specific cognitive domains affected by MS.(Blair et al., 2021)

The meta-analysis conducted by Di Tella et al.(Di Tella et al., 2020) has encompassed a broader examination of telerehabilitation (TR) strategies spanning various neurodegenerative conditions. While our investigation revealed notable enhancements in cognitive function following telerehabilitation-based interventions, other studies observed that integrated TR approaches predominantly targeted physical aspects, such as mobility and balance, with limited impact on cognitive impairments. In our study, alongside evaluating cognitive function, we assessed various parameters related to physical well-being, such as mobility and activities of daily living, as well as psychological aspects, including anxiety, depression, and overall satisfaction with life. By incorporating these multifaceted assessments, our study sought to provide a comprehensive understanding of the holistic effects of telerehabilitation interventions on individuals living with MS.

The meta-analysis conducted by Cotelli et al. (Cotelli et al., 2019) They concluded that cognitive training and rehabilitation, known as telerehabilitation (TR), has been found to be more effective than traditional face-to-face interfaces in treating neurodegenerative disorders. The present study also yielded positive results in improving cognitive abilities, with a significance level of p=0.049.

Tollár et al. showed that only a few studies have assessed the literature on the effects of exercise training on the Multiple Sclerosis Impact Scale (MSIS-29). With home-training EXE using the Nintendo Wii Balance Board System, there was a 12% improvement in MSIS-29 scores and quality of life. (Tollár et al., 2020) This study shows changes in multiple sclerosis impact scores (MSIS) over time to affirm the efficiency of the treatments for these symptoms (p = 0. 035). Consequently, it can be implicit that the integration of TR in cognitive training programs for MS patients might further improve effectiveness. Hence, it is suggested to continue studying and applying the concept of telerehabilitation besides the conventional rehabilitation methods for managing cognitive impairment in MS patients.

CONCLUSIONS

To summarize, telerehabilitation based on task-specific training can help improve the cognitive

functioning of patients with multiple sclerosis (MS). The telerehabilitation group A had higher cognitive function than the group B, which underwent traditional cognitive rehabilitation intervention.

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