



The Effect of Telerehabilitation on People with Sensory Disabilities: A Systematic Review

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Abstract

Introduction: Sensory disabilities, including hearing or speech and vision loss, are the second biggest contributor to rehabilitation needs in terms of the number of affected people. Therefore, the aim of this systematic review of randomized clinical trial was to investigate the effect of telerehabilitation on people with sensory disabilities, including hearing, speech and visual impairments.

Methods: A systematic review was conducted in a randomized controlled trial (RCT), pilot, and protocols for RCT studies without time limit by searching for keywords in the title, abstract and study keywords in valid scientific databases Embase, Web of Science, Scopus, and PubMed on October 23, 2021. We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

Results: In total, 1080 documents were initially retrieved through scientific database searching. Finally, 8 eligible studies were found through this review. The quality assessment results showed that there was no significant bias in the studies and all quality studies were included. The sample sizes in the studies ranged from 21 to 203 participants. Follow-up periods ranged from 6 weeks to 12 months. Of the 8 included studies, 4 were experimental and did not provide definitive results. However, in 4 studies, patients reported improvements in hearing, speech, mental status, quality of life, and self-care skills.

Conclusion: The results of the present systematic review revealed that using telerehabilitation improves the provision of rehabilitation services in patients with sensory disabilities (hearing, speech, and visual impairment). Hence, telerehabilitation is a safe, effective, and feasible tool for providing telerehabilitation services.

Keywords: Telerehabilitation, Remote rehabilitation, Disability, Telemedicine, eHealth

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Introduction

About 15% of the people in the world have experienced disability (1). A person with disability is one in whose health and general efficiency a continuous and significant disturbance have been caused as a result of a physical, mental, psychological or combined injury, in a way that his/her independence is reduced. Disability is now recognized as a multidimensional and dynamic concept that has long and variable durations and covers a wide range of medical data (2, 3). According to the Standard Rules on the Equalization of Opportunities for Persons with Disabilities, the term “rehabilitation” (4) refers to a process that aims to enable people with disabilities to achieve and maintain their physical well-being at sensory, intellectual, psychiatric and/or social level, thus providing them with tools to

change their lives to a higher level of independence. According to the World Health Organization’s (WHO) estimates in 2019, 2.41 billion individuals around the globe need rehabilitation services, implying that one out of three persons during a period of illness or injury requires such services (5). Since 1990, this estimate has increased, indicating the aging phenomenon in the concerned population. Sensory disabilities, including hearing or speech and vision loss, are the second biggest contributor to rehabilitation needs in terms of the number of people affected. They are among the largest contributors to the need for rehabilitation in children aged under 15 and older adults (6). Moreover, evidence suggests that, regardless of the severity of the Covid-19 disease or the hospitalization period following its acute phase, many individuals affected with this virus experience

long-term complications; hence, there is an increase in demand for rehabilitation services worldwide (7, 8). Traditional care systems are not able to respond to the comprehensive needs of the people with disabilities. On the other hand, with the prevalence of Covid-19 pandemic, receiving face-to-face services is also a risk factor in people with disabilities (9).

Medical technologies and telerehabilitation have been considered an increasingly innovative approaches (10). Telerehabilitation refers to the provision of telerehabilitation services using communication technologies (11). Telerehabilitation includes applications such as counselling, home care, monitoring, treatment, and patient self-care that are offered in a variety of settings, including the home, community, health care centres, and the workplace (12). Physicians and other rehabilitation care providers mainly use telerehabilitation technology to visit the patients remotely (13). This is especially true in the context of disability, given that people with disabilities and their families often face barriers such as physical problems and disabilities that prevent them from being physically present for treatment, the shortage of rehabilitation specialists, and barriers to long-distance travel (14). Recent advances in telerehabilitation of disability have made it possible to provide rehabilitation services to medically disadvantaged areas and low-income countries (15). Overall, this has led to improved access to health care and rapid assessing, monitoring, and treating of patients (13, 14). Numerous studies have reported that these benefits, along with the cost-effectiveness of videoconferencing visits (i.e., compared to face-to-face visits), have improved the quality of life of patients and their caregivers (16-18).

Telerehabilitation has been performed in other areas of rehabilitation such as respiratory rehabilitation, cardiac rehabilitation, cancer rehabilitation, neurological rehabilitation, and spinal cord injuries (19-21, 13). However, to the best of our knowledge, no systematic review has been performed to evaluate the effect of telerehabilitation in patients with sensory disabilities. Therefore, the aim of this systematic review of randomized clinical trial (RCT) was to investigate the effect of telerehabilitation interventions in people with sensory disabilities, including hearing, speech, and visual impairments.

Methods

Study Design

We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to report on evidence from the studies

that were included in this systematic review (22, 23). We conducted a literature search on the PubMed, Embase, Scopus, and Web of Science databases on October 23, 2021. The following keywords and MeSH terms were used to do the search for title, abstract and keyword in the databases search: “Disabled Persons”, “People with Disabilities”, “Disability”, “Disabled”, “impairment”, “Handicapped”) AND (“Telemedicine”, “Telerehabilitation”, “telehealth”, “Mobile Health”, “eHealth”, “mHealth”). First, the titles and abstracts were screened independently based on eligibility criteria. Articles that did not meet the inclusion criteria were excluded from this systematic review. Complete texts were then retrieved and screened by two separate researchers based on eligibility criteria. Disagreements between researchers were resolved through discussion. In case of disagreement, the third researcher gave the final opinion.

Eligibility Criteria

Studies were included if they met the following inclusion criteria: 1) Original RCTs, pilot, and protocols for RCT studies that had used telerehabilitation interventions for people with sensory disabilities; and 2) The language of the articles had to be English. On the other hand, the exclusion criteria were: 1) type of publication other than journal articles (e.g., books, review papers, and letters); 2) lack of availability of the full text in the English language; and 3) lack of relationship of the title, abstract, or full text of the papers to sensory disabilities. This systematic review was limited to RCTs, so that we could evaluate the studies with the highest quality of evidence. However, due to the necessity of the subject and limited available evidence, we included pilot and protocols for RCT studies.

Data Extraction and Synthesis

A standardized form was used for data extraction. The data items in this form included the publication title, first author's name, publication year, study design, study goals, and the telerehabilitation approach used, The type of disability, and main study findings, duration of the interventions, and the participants' characteristics (Number and mean age of them).

Quality Assessment

In order to assess the quality of the studies, we used the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for RCTs (24). Specifically, 13 questions were used to evaluate the quality of these studies. If

the response to a question was yes, the score was 1; otherwise, the score was 0. Therefore, the maximum quality score that each study could obtain was 13. If it was less than 7, it was removed from the study.

Results

Study Selection

The process of identifying and selecting the studies based on the PRISMA diagram is shown in Figure 1. In total, 1080 documents were initially retrieved through scientific database searching, 355 of which were duplicates. Among the retrieved articles, 712 documents were excluded after screening for the title and abstract. Finally, 8 eligible studies were found through this review.

Quality Assessment

The quality assessment results displayed in Table 1 show that there was no significant bias in the studies and all quality studies were included in our study.

Study Characteristics

The characteristics of the 8 included studies are reported in Tables 2 and 3. Of them, 2 (25%) were associated with the telerehabilitation in speech and language disabilities (28, 31). 4 (50%) were related to hearing impairment (25-27, 29), and 2 (25%) were associated to visual impairment (6, 32). The sample size in the studies ranged from 21 (32) to 203 participants (25). The average or median age of the participants ranged from 13 months (28) to 73.5 years (25). The designs of the studies were classified into three categories of RCTs (4/8, 50%) (25-27,

29), protocol for a Crossover RCT (1/8, 12.5%) (32), protocol for a RCT (1/8, 12.5%) (9), and Pilot RCT (2/8, 25%) (28, 31). Follow-up periods ranged from 6 weeks (25) to 12 month (9, 32).

Speech Impairment

Two studies supported telerehabilitation for patients with impaired speech (28, 31). Øra et al. conducted a pilot study to investigate the effect of reinforced telerehabilitation via video conference as a proper rehabilitation method for aphasic patients after stroke compared with the routine care, which showed no evidence of improvement of patients in the intervention group compared with the controls. However, both groups showed improvement in the Norwegian Basic Aphasia Assessment. Thus, reinforced telerehabilitation via video conference showed no adverse effects and might be considered as a proper method for aphasia rehabilitation, which affects the language and speech outcomes in stroke patients. Though, due to the limited sample size, they stated that an RCT on 230 patients is required to confirm the results of their study (31). Another study was conducted by Peter et al. on telerehabilitation of the neonates with classic galactosemia (CG), a metabolic disorder characterized by a high risk of language and speech disorders, using a distant computer interface according to HIPAA. Using this computer interface, language and speech pathologists made direct inspections of the child and parents' interactions during the intervention. This educational method consisted of the following steps: 1) describing the activity, 2) modeling the activity, 3) giving

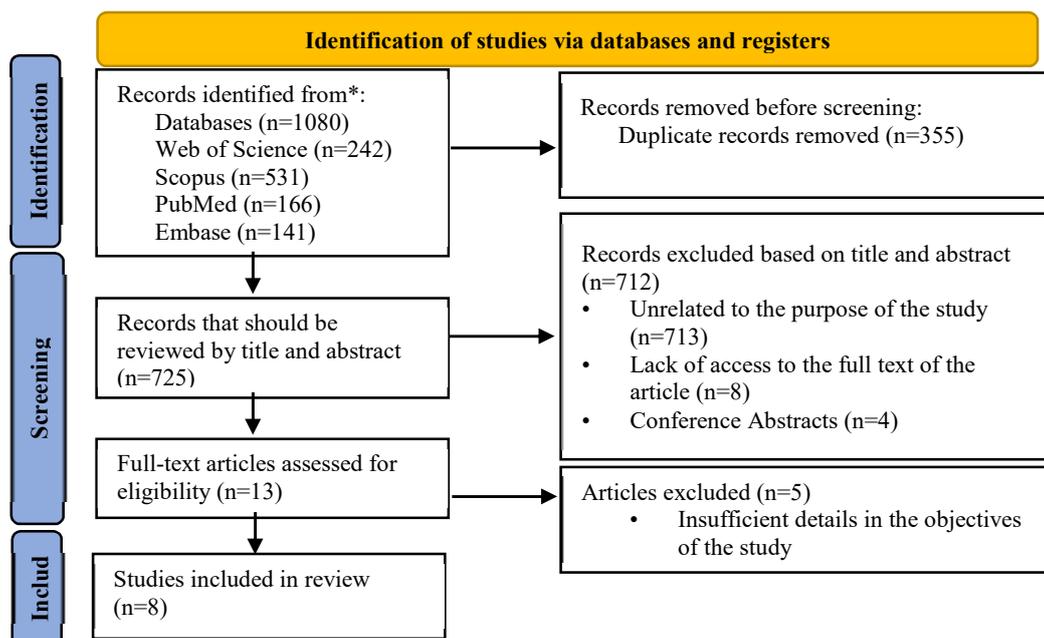


Figure 1: Flow diagram of the systematic search and study selection.

Table 1: Summary of the quality assessment using the Joanna Briggs Institute (JBI) checklist for randomized controlled trials

Study	Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	Was appropriate statistical analysis used?	Were outcomes measured in a reliable way?	Were outcomes measured in the same way for treatment groups?	Were participants analyzed in the groups to which they were randomized?	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Were treatment groups treated identically other than the intervention of interest?	Were outcomes assessors blind to treatment assignment?	Were those delivering treatment blind to treatment assignment?	Were participants blind to treatment assignment?	Were treatment groups similar at the baseline?	Was allocation to treatment groups concealed?	Was true randomization used for assignment of participants to treatment groups?	Score, n
Melanie Ferguson (25)	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	11
Jonathan Greenberg (26)	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	10
Camila Piccini Aiello (27)	U	U	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	8
Beate Peter (28)	U	U	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	9
Helen Cullington (29)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	12
Hege Prag Øra (30, 31)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	11
NCT03957980 (32)	Y	Y	Y	Y	N	N	Y	Y	U	Y	N	Y	Y	9
NTR6082 (9)	Y	Y	Y	Y	N	N	Y	Y	U	Y	N	Y	Y	9

Y: Yes, N: No, U: Unclear

Table 2: Characteristics of the participants in all included studies

First author's name, Reference	Participants' characteristics	
	Mean age of participants	Number of participants
Melanie Ferguson, 2016, (25)	73.5 years	Total:203 Control:103 Intervention:100
Jonathan Greenberg, 2019, (26)	41.35 years	Total:46 Control:21 Intervention:24
Camila Piccini Aiello, 2015, (27)	27 years	Total:22 Control:11 Intervention:11
Beate Peter, 2020, (28)	13 month	Total:25 Control:1 Intervention:4
Helen Cullington, 2017, (29)	Over 18 years	Total:60 Control:30 Intervention:30
Hege Prag Øra, 2018, 2020, (30, 31)	65 years	Total:62 Control:30 Intervention:32
NCT03957980, 2017, (32)	3.5 years	Total:21 Control:10 Intervention:11
NTR6082, 2016, (9)	Over 50 years	Total:174 Control:87 Intervention:87

Table 3: Summary of the study characteristics from all included studies

First author's name, Reference	Study design	Study goals	Type of disability	Duration of interventions	Outcome measures	Telerehabilitation approach	
						Intervention	Control
Melanie Ferguson, 2016, (25)	RCT	(1) Develop a series of short interactive videos (or reusable learning objects (RLOs) covering a broad spectrum of practical and psychosocial topic relevant to the auditory rehabilitation for first-time hearing aid users; (2) establish the accessibility, take-up, acceptability and adherence of the RLOs; and (3) assess the advantages and cost-effectiveness of the RLOs.	Hearing	6 weeks	RLOs may provide useful learning and educational support for first-time hearing aid users and could be used to complement clinical rehabilitation practice.	RLOs plus standard clinical service including hearing aid(s). (RLOs included video clips, images, animations, photos, sounds, and descriptions, and all were subtitled.)	Standard clinical service including hearing aid(s)
Jonathan Greenberg, 2019, (26)	RCT	Evaluation of the effect of mind-body resiliency program (the Relaxation Response and Resiliency program for Deaf NF2; d3RP-NF2) versus a health education control (Health Enhancement Program for Deaf NF2; dHEP-NF2)	Neurofibromatosis2 (NF)	8 weeks	The d3RP-NF2 sustainably improves various dimensions of elasticity.	Mind-body resiliency program (the Relaxation Response and Resiliency program for Deaf NF2; d3RP-NF2) via Skype using communication Access real-time translation. This program improves resiliency factors (such as optimism, gratitude, perceived social support, mindfulness, and perceived coping abilities)	Health education control (Health Enhancement Program for Deaf NF2;dHEP-NF2)
Camila Piccini Aiello, 2015, (27)	RCT	Evaluate the effectiveness of an online social network as a support for parents of children with hearing impairment.	Hearing impairment	3 months	This study indicated the potential of this network to support parents of children with hearing impairment.	"Babies' Portal" social network	---
Beate Peter, 2020, (28)	Pilot parallel RCT	The effect of an innovative proactive speech and language intervention program, the Babble Boot Camp (BBC).	classic galactosemia (CG)	-	All treated children had higher speech sound skills in babble, compared to the control child with CG	Telepractice with the parents	-
Helen Cullington, 2017, (29)	RCT	Feasibility study of comparing a remote care with the standard care in adults using cochlear implants.	Cochlear implants.	6 months	Personal remote care is possible and acceptable for long-term follow-up and leads to more empowerment of patients.	Remote care included home hearing in noise test, online support tool and self-adjustment of device	Usual care pathway

Hege Prag Øra, 2018, 2020, (30, 31)	Pilot RCT	Feasibility and effectiveness of telerehabilitation in post stroke aphasia in addition to usual care	Post stroke aphasia	4 months	Augmented telerehabilitation via videoconference may be a viable rehabilitation model for aphasia affecting language outcomes post stroke.	The telerehabilitation by videoconference targeted functional, expressive language.	Usual care, speech and language therapy (SLT)
NCT03957980, 2017, (32)	Protocol for cross-over RCT	Comparison, effectiveness, feasibility and acceptability of an in-home telehealth-based intervention to standard care for children with cortical visual impairment and their caregivers.	Cortical visual impairment	12 months	Not yet provided	Occupational therapy via telehealth	Not receive an intervention
NTR6082, 2016, (9)	Protocol for Randomized parallel-group trial	Evaluate to examine the feasibility of E-PsEYE	Retinal exudative	12 months	Not yet provided	An electronic mental health intervention based on cognitive-behavioral therapy (provided via the Internet) will be investigated, consisting of nine modules designed to reduce depression and anxiety and increase adaptation to vision loss.	Not applicable

feedback when parents are training, 4) giving feedback on the home video, 5) evaluating it in the next session in the next week with parents and discussing the current skills of the child, and 6) discussing the methods to expand these skills to further goals with parents. Their study showed the beneficial effects of this method on voice production, speech, verbal language, and milestones in the child’s communication. The definitive conclusion was not made due to the limited sample size (28).

Hearing Impairment

Telerehabilitation interventions have been investigated in four studies in controlling and improving the hearing impairment (25-27, 29). The technologies used in telerehabilitation in patients with hearing impairments include reusable learning objects (RLOs) such as video clips, images, animations, photos, sounds and descriptions (25), live video-conferencing on flexibility training in patients with neurofibromatosis type 2 showing hearing loss to deafness symptoms (26), online social network or “Portal of Children” to support the parents of children with hearing impairment (27), and online personal support tool (29) that resulted in self-management in patients with hearing impairment. The results of two of these studies showed no significant improvement in the intervention group compared to the controls (27, 29). Still, evidence supported the higher efficacy of the interventions with RLO technology and live video conferences compared with the standard treatment (25, 26). RLOs provided valuable training support for those using hearing aids for the first time and can be used to complete the exercises of clinical rehabilitation since they are cost-effective due to unlimited usage of one-time production (25). Effective training through video conferences in patients with neurofibromatosis type 2 with hearing loss to deafness symptoms was generally focused on increasing the auditory flexibility by targeting flexibility dimensions, including optimism, gratitude, perceived social support, mindfulness, and perceived coping abilities for their improvement (26).

Visual Impairment

Studies provided no evidence of the effectiveness of telerehabilitation in visual impairment. Only two ongoing studies on patients with visual impairments have

investigated the subject using telemedicine, probably providing evidence on the potential effectiveness of telerehabilitation as a platform of providing services to patients with visual impairment (9, 32).

Discussion

Principal Findings

The present systematic review of RCTs aimed to investigate the effects of telerehabilitation on patients with sensory disabilities, including hearing, speech, and visual impairments. In most studies, telemedicine and telerehabilitation technologies are still used in training, treatment adherence, and remote monitoring (25, 26, 28, 31). None of the investigated studies used sophisticated technologies, such as robot surgeons. The majority of them were experimental and did not provide definitive results (27, 28, 30, 31), though the evidence shows no side effects of remote interventions with at least the same effects on the control and intervention groups (31). However, in some cases, patients reported improvements in hearing, speech, mental status, quality of life, and self-care skills (25, 26, 28).

The present systematic review showed the positive attitude of most patients on the telerehabilitation interventions. In addition, participants stated that they liked to use social media for treatment because it provided a platform for the exchange of information and experience with other patients and health care professionals about their disability. As Preece et al. reported, people who are active in online groups send more messages form powerful links with the group (33). Furthermore, it increases the awareness and reduces the parents' stress about their child's disability. In contrast, the so-called "observers" are those who only read forum discussions, and chats but seldom or never actively participate (34). They receive fewer benefits from participating in social media. Therefore, encouraging the participation of observers can be an important factor in improving the patients' awareness and treatment process (7). Learning through the exchange of experiences and the sharing of feelings, doubts, and anxiety reduces the patients' suffering (27, 34-37).

One of the ethical concerns of using online groups is to expose false or misleading information about a disorder, prognosis and/or treatment for ordinary people. However, in many cases, such incorrect information can be corrected by other group members and managers. In addition, telerehabilitation with the help of online video conferencing has led to a significant increase in the ability to repeat words and produce sentences in speech impaired people (31).

Consistent with the present study results, Kerry et al. (2018) conducted a systematic review to investigate the clinical outcomes, clinical procedures, uses, and costs associated with telerehabilitation in individuals with physical impairment. Their study showed the cumulative evidence on the efficiency and effectiveness of telerehabilitation, though high-quality evidence is required regarding the effect on resource allocation and costs to support clinical decision-making and policy-making (38). Moreover, Nesbam et al. (2019) conducted a systematic review to better outline the method of using mobile medical applications regarding physical medicine and rehabilitation. The results of their study demonstrated the possible positive effects of some mobile applications when used as a self-management system or as a measurement tool to provide exercise interventions or walking exercises (39).

There were other cases that showed that distance medical services were comparable to the general public and pediatric's care (40), anxiety of children's treatment (11), and patient care with Chronic Obstructive Pulmonary Disease (10). In contrast, several studies have reported some problems with telerehabilitation and medical services as expense, bandwidth problems, insufficient equipment, lack of users' training or security, which should be considered to increase access to remote services (13, 41-45).

In summary, the results of our systematic review show that the use of telerehabilitation improves rehabilitation services in patients with sensory disabilities (hearing, speech and vision). However, overcoming the barriers and challenges of these interventions is still necessary.

Strengths and Limitations

Other systematic reviews have been conducted on telemedicine or telerehabilitation in different fields, though no studies have comprehensively investigated telerehabilitation in patients with sensory disabilities. In addition, only RCTs were included, which reduced the study bias and provided credible evidence.

One of the limitations of the present review was that not all disabilities were assessed in the telerehabilitation intervention, which reduced the possibility of accurate synthesis of studies due to the comprehensiveness of the disability. On the other hand, the search keywords may not be sufficient and complete to receive further studies, and some prominent and relevant studies may have been missed in this study. Additionally, this study included only peer-reviewed studies published in scientific journals and conferences; therefore, articles published in the gray literature are not included in the present study.

Also, the included studies had heterogeneous designs and used different methods for measuring the outcomes of telerehabilitation; therefore, performing meta-analysis and investigating the effect of these studies were not possible as a group.

Conclusion

The results of the present systematic review revealed that using telerehabilitation improved the provision of rehabilitation services in patients with sensory disabilities (hearing, speech, and visual impairment). Hence, telerehabilitation is a safe, effective, and feasible tool for providing telerehabilitation services. It is recommended that future studies should focus on improving the patients' access to rehabilitation services and removing barriers to telerehabilitation to maximize the potential of telerehabilitation.

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Authors' Contribution

SFMB contributed to the search strategy, protocol design, initial draft of the manuscript, and data extraction; ASM contributed to the search strategy, data extraction, study selection, and study evaluation; KK edited the manuscript; and MS designed the study and edited the manuscript. All authors read and approved the final version of the submitted manuscript.

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Ethics Approval and Consent to Participate

This study was approved by the ethics committee of Mashhad University of Medical Sciences (approval number IR.MUMS.REC.1400.296).

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