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Review Article

Investigating the Effects of Telerehabilitation on Improving the Physical Activity of Individuals with Multiple Sclerosis: A Systematic Review of Randomized Controlled Trial

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ABSTRACT

Introduction: This study systematically evaluates the effect of telerehabilitation on improving physical activity, physical function, and quality of life (QoL) in individuals with multiple sclerosis (MS).

Materials and Methods: Studies were obtained by searching the title, abstract, and keywords without time limit in the Scopus, PubMed, Embase, and Web of Science databases. The quality of the included studies was assessed using the Joanna Briggs institute checklist. The same checklist was used for data extraction.

Results: A total of 16 eligible articles were found. In 12 studies, the results showed significant performance improvement, reduced fatigue, improved physical activity, and general balance in the telerehabilitation approach. Furthermore, of the 16 included studies, 5(31) reported an improvement in individuals' QoL, two of which showed a significant improvement in the individuals' QoL in the intervention group compared to the control group.

Conclusion: The findings of this review showed that telerehabilitation services for MS individuals' precautions are comparable to or better than conventional services. Telerehabilitation is an effective educational instrument to restitute and maintain physical activity and balance in individuals with MS; however, no considerable improvement in individuals' QoL was reported.

Keywords:

Multiple sclerosis; Telerehabilitation; Remote rehabilitation; Physical activity

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Introduction

Multiple sclerosis (MS) is an inflammatory disease in which the myelin sheaths of nerve cells in the brain and spinal cord are damaged and affects about 1.3 million people worldwide [1]. People with MS show various deficits, such as physical, fatigue, pain, incontinence, cognitive, psychosocial, behavioral, and environmental problems which limit their function and participation [2]. Although many services and advances have been made to manage MS worldwide, many individuals cannot access these improvements due to limited mobility, a lack of balance, fatigue and related matters, and travel-related costs [3]. Also, the MS rehabilitation program requires several consecutive sessions throughout its care plan. For individuals with limited mobility and mobility impairments, traveling to hospitals and health centers for treatment can be laborious and often costly, which can hinder access to rehabilitation treatment. Furthermore, the programs used for the functional rehabilitation of individuals with MS need multiple rehabilitation physical practices. These methods have two fundamental problems. First, they suggest practicing motor controls by performing physical practices consistently and reiteratively. This lacks motivation, reduces individuals' interest in doing them, and affects their adherence to treatment. Second, these processes need individuals to be in particular facilities with the supervision of experienced providers to ensure proper efficiency [4].

With increasing financial constraints governing healthcare systems, alternative ways of providing services in the long run are now a priority. Telerehabilitation for individuals with MS is possible as an innovative approach to improve healthcare by reducing care costs [4, 5]. Telerehabilitation refers to providing rehabilitation services with the help of communication and information technologies. This may include various types of technology, such as mobile applications, Internet-based communications, virtual reality applications, or a combination of other forms of computer systems and technologies. When used for preventive, curative, and rehabilitative services and outcome monitoring, such technologies are used as tools to provide guidelines and solutions to address rehabilitation issues [4-6]. Telerehabilitation is a promising strategy and may mainly make rehabilitation accessible and more efficient for people with long-term rehabilitation necessities, such as individuals with MS [6].

Although previous systematic reviews (2015) have examined the effect of telerehabilitation in individuals with MS, no recent systematic review has focused on improving physical conditions resulting from telerehabilitation compared to traditional rehabilitation [7, 8].

Review studies help summarize and analyze the results of existing studies. They are useful tools for clinical decisions and planning, especially in newer research where the quality and scope of studies vary significantly. It also helps identify evidence that is currently lacking in research. Although studies in the field of telerehabilitation are progressing [7], the lack of a review study on the impact of telerehabilitation in improving the physical activity of people with MS in a comprehensive approach prevents the developers and health policymakers from creating a general view of these systems.

Accordingly, this review systematically evaluates the effect of telerehabilitation on improving physical activity, physical function, and quality of life (QoL) in MS individuals. It determines whether telerehabilitation procedures can substitute conventional in-person care procedures.

Materials and Methods

Study protocol

This review followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines to report results from studies included in this systematic review [9, 10]. The PRISMA checklist is included in Appendix 1. We conducted a literature search on the PubMed, Embase, Scopus, and Web of Science databases on October 20, 2021. The following keywords and MeSH terms were used to conduct the database search: ("Physical therapy modalities," "exercise therapy," "exercise therapy," "physiotherapy," "exercise") AND ("telemedicine," "telerehabilitation," "telehealth," "mobile health," "ehealth," "mHealth"). The randomized control trial filter was applied to the search strategy.

Eligibility criteria

Original randomized controlled trials (RCTs) that used telerehabilitation or tele-physiotherapy modalities to improve physical function and physical activity in MS individuals were eligible for this review. The inclusion criteria included original RCT studies, MS individuals, and a focus on telerehabilitation as a study intervention. The exclusion criteria were the type of publication, excluding journal articles, the lack of access to the full text of the article in English, and being irrelevant to the purpose of this review.

Data extraction and synthesis

Data extraction was done independently by two authors using a standardized form. The data items in this form included the following items: Publication title, first author's name, publication year, participants' characteristics (number of participants, gender, type of MS [benign, relapsing-remitting, secondary progressive, primary progressive, and unknown] and age [year]), the primary intervention strategy that was used, follow-up period, outcome measures, and results. Titles and abstracts were first screened independently by two authors based on the inclusion and exclusion criteria. Complete texts were independently retrieved and reviewed based on inclusion, exclusion, and quality assessment criteria. Disputes were resolved by discussion, and the third author would give the final opinion in case of disagreement.

Quality assessment

The quality assessment of the included studies was done using the Joanna Briggs Institute's (JBI) critical evaluation checklist for RCT studies [11]. In particular, the research acquired 13 questions to assess the quality of these studies and categorize the questions into two segments ("yes" and "no"). if the answer to a question was "Yes," it was indicated as 1, and the answer "no" was marked as 0. Consequently, each study could achieve a maximum quality score of 13, and exclusion only takes effect if the quality score is less than 7.

Results

Study selection

The process of extracting and selecting the studies for this review based on the PRISMA diagram is shown in Figure 1. Overall, 2142 studies were first extracted through searching in scientific databases. A total of 683 were duplicates, and 1459 references remained after excluding duplicates. Afterward, after the title and abstract review, 1376 documents were excluded from the retrieved articles. Among the retrieved articles, 67 documents were excluded after the full-text screening. Eventually, 16 eligible articles were included in the review.

Quality assessment

According to Table 1, the results of the quality assessment of the included studies show no significant bias, and all the quality studies are included in our review.

Study characteristics

According to Table 1 and Table 2, of the 16 included studies, 4(25) studies were conducted in Spain [12-15], 3(19) studies were conducted in UK [16-18], 2(12.5) studies were conducted in Iran [19, 20], 2(12.5) studies were conducted in USA [21, 22], and other studies in Turkey [23], Netherlands [24], Italy [25], Czech Republic [26], and Germany [8]. The studies' sample sizes ranged from 11 participants [14] to 208 participants [22]. Follow-up periods ranged from 4 weeks [18] to 9 months [17].

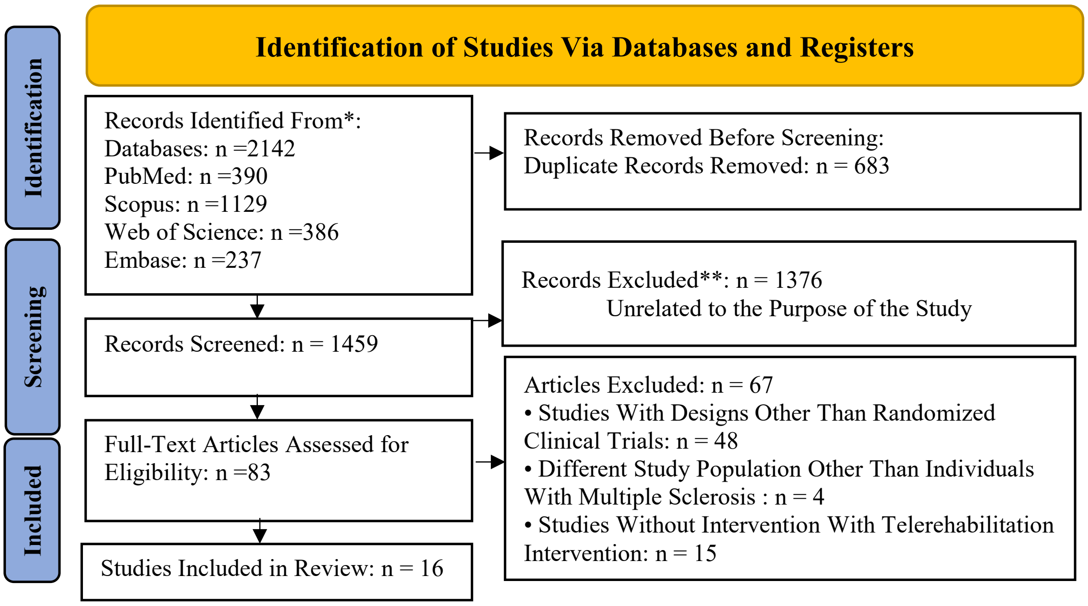

Figure 1. Flow diagram of the literature search and study selection

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Table 1. Summary of study characteristics and the quality of evidence from all included studies

Author, Year, Country	Main Intervention Strategy	Outcome Measures	Results	Follow-up Period	Quality Assessment Score
Ortiz-Gutiérrez et al. 2013, Spain [12]	VR-video games	Computerized dynamic posturography and clinical outcomes (leaf balance and Tintetti scale) were used to measure the outcome at the beginning and end of the treatment.	Improvements in balance and postural control were seen in individuals with MS after completing a training program using virtual reality video game technology or a conventional rehabilitation program. A training program may be an important alternative to standard rehabilitation treatments for balance and postural control (PC) in individuals with MS.	10 weeks (control: Twice a week [40 min per session]; Intervention: Four times a week [40 min per session])	9
Cuesta-Gómez et al. 2020, Spain [13]	VR associated with serious games for upper limb rehabilitation	Grip muscle strength, coordination, movement speed, fine and gross upper limb (UL) skills, fatigue, quality of life, satisfaction, and compliance were evaluated in both groups before treatment, after treatment, and in a 1-month follow-up period without receiving anything.	In the experimental group, compared to the control group, significant improvements were observed in the evaluation after treatment regarding coordination, speed of movements, and fine and gross upper limb dexterity. Also, effective results were found in follow-ups in coordination, speed of movements, and fine and gross for the injured party. The use of serious leap motion controller (LMC)-based games designed for upper limb rehabilitation showed improvements in unilateral manual dexterity, fine manual dexterity, and coordination in MS individuals with high satisfaction and excellent compliance.	10 weeks (60 min sessions per week over ten weeks) and follow-up period of 1 month without receiving any treatment	10
Lozano-Quilis et al. 2014, Spain [14]	RemoviEM (RemoviEM is a Kinect-based system that uses VR and natural user interfaces to provide MS individuals with an intuitive and motivational way to perform multiple motor rehabilitation exercises).	Clinical outcomes were measured using clinical balance scales.	In the experimental group, further improvement was observed in the scores of the Berg balance scale (P=0.011) and the anterior reach test in standing position (P=0.011). The results show that RemoviEM is a motivational and effective alternative to traditional motor rehabilitation for individuals with MS.	10 weeks (ten 1-h sessions and one session every week)	10
Waliño-Paniagua et al. 2019, Spain [15]	Game-based virtual reality video capture training program	The 9-hole nail test was used to determine the eligibility of individuals with MS for testing and assessment of their upper extremity function.	Compared to a conventional occupational therapy intervention with an occupational therapy + virtual reality intervention in individuals with moderate MS, manual dexterity has no significant difference. However, individuals who received the occupational therapy + virtual reality intervention showed clinical improvements in the accuracy of certain upper limb movements, faster execution times for specific tests, and greater effectiveness during specific functional tasks. Virtual reality using upper limb movement video can complement operational therapy in treating manual dexterity in individuals with MS.	10 weeks (twice weekly and lasting 30 min)	9

Author, Year, Country	Main Intervention Strategy	Outcome Measures	Results	Follow-up Period	Quality Assessment Score
Paul et al. 2014, UK [16]	Web-based physiotherapy	The following outcomes were completed at baseline and after 12 weeks. The 25-foot walk, leaf balance, timed and movement scale, MS impact scale, leeds MS quality of life scale, MS-related symptom checklist, and hospital anxiety and depression Scale. The intervention group also completed the website evaluation questionnaire and interview.	There were no statistically significant differences in the primary outcome measurement, 25-foot walking scheduled in the intervention group (P=0.170), or other secondary outcome measures, except for the MS impact scale (P=0.048). However, MS individuals were very positive about web-based physiotherapy. The results showed that 80 participants, 40 in each group, were sufficient for a fully powered and definitive randomized controlled trial.	12 weeks (twice per week)	8
Paul et al. 2019, UK [17]	Web-based physiotherapy	Outcome measures (0, 3, 6, and 9 months) included adherence, a 2-min walk test, a 25-foot walk, a leaf balance scale, physical activity, and use of health care resources.	There were no significant changes over time in outcome measures except EQ-5D at six months, which improved in the active comparison group. This study was acceptable and feasible by the participants and physiotherapists.	Nine months (3, 6, and months after treatment)	10
Robinson et al. 2015, UK [18]	Exergaming using the nintendo wii fit™ system	Outcome measures included postural sway using the KistlerTM force platform, spatiotemporal parameters of gait using a GAITRiteTM computerized corridor, technology acceptance, and flow experience, respectively, using the integrated theory of technology acceptance and use of questionnaire and flow status scale.	There was no significant difference in gait and technology acceptance between the two groups; however, the Wii Fit ™ is comparable to traditional balance exercises in terms of the physical effects of exercise. It supports using Wii Fit™ as an effective means of training balance and walking for people with MS, which is acceptable and motivating for individuals with MS.	Four weeks (four weeks of twice weekly)	8
Molhemi et al. 2021, Iran [19]	VR-based balance training	Limits of stability timed and 10-m walking tests with and without cognitive task and their dual-task cost, leaf balance scale, MS walking-scale-12, autumn international effectiveness scale, confidence scale, the special balance of activities and history of autumn before and after the intervention and after a three-month follow-up was obtained.	Both virtual reality-based and conventional balance exercises improved balance and mobility in MS patients, while each performed better in certain aspects. Virtual reality training enhanced cognitive motor function and reduced falls, while conventional exercise resulted in better directional control.	3 months follow-up after the intervention	11
Norouzi et al. 2021, Iran [20]	VR-based bi-manual coordination task	The effectiveness of three interventions for learning a bimanual coordination task was measured, including virtual reality training, conventional physical training, and a combination of virtual reality training and conventional physical training.	Compared to virtual reality training and conventional physical therapy conditions, the virtual reality training + conventional physical therapy conditions resulted in higher coordination accuracy and compatibility. Therefore, this combination has the potential to accelerate the improvement of motor control and rehabilitation of women with MS.	3 months after the treatment	8

Author, Year, Country	Main Intervention Strategy	Outcome Measures	Results	Follow-up Period	Quality Assessment Score
Conroy et al. 2017, USA [21]	Web-based exercise programme	Outcome measures were timed 25-foot walk, 6-min walk, and leaf balance scale.	No statistically significant differences were observed in the measured variables; however, adherence to exercise was positively associated with higher MS disability and reported self-walking ability.	Six months after the treatment	8
Plow et al. 2019, USA [22]	Telephone-delivered physical activity and fatigue self-management	The primary outcomes of self-reported fatigue and physical activity were measured using the fatigue impact scale and the Godin leisure exercise questionnaire. Secondary outcomes included quality of life with the MS impact scale, moderate to vigorous exercise, and the number of steps measured with an accelerometer.	Group telephone conferences, followed by tailored telephone calls, have a small but statistically significant effect on promoting physical activity and reducing the effect of fatigue in people with MS.	24 weeks (6, 12, and 24 weeks after treatment)	9
Yazgan et al. 2019, Turkey [23]	Exergaming systems on balance, functionality, fatigue and quality of life	The outcome measures were the balance sheet scale, timed go test, 6-min walk test, fatigue severity scale, and MS international quality of life questionnaire. It is also done after treatment.	Compared to non-intervention, exergaming with the Nintendo Wii Fit and balance trainer improves balance performance, reduces fatigue, and improves the quality of training in MS patients.	8 weeks (2 days a week for 8 weeks)	9
Hermens et al. 2008, Netherlands [24]	Homecare Activity Desk Via Video Conferencing	The outcome measures were the action research arm and the hole peg test.	The homecare activity desk system is at least as effective as standard care.	1 month (one training session a day lasting 30 minutes for 5 days a week)	8
Peruzzi et al. 2016, Italy [25]	VR-based training on gait	The outcomes measured were clinical measures and gait parameters.	The experimental group improved significantly more than the control group in the range of motion of the pelvis and the strength produced in the terminal stance post-training.	6 weeks (for a total of 18 sessions)	10
Novotna et al. 2019, Czech Republic [26]	Rehabilitation homebalance® system	The primary outcome was the leaf balance test. Secondary outcome measures included the mini-BESTest, timed up and go test (part of the mini-BESTest), and spatiotemporal gait parameter assessment using the GAITRite tool.	Compared to non-intervention, a short-term balance exercise program at home using Homebalance® improved balance but not gait performance in a group of people with MS.	2 month (four weeks of home-based balance training and follow-up after four weeks)	10
Tallner et al. 2016, Germany [6]	Internet-based exercise training (e-training)	Primary measured outcomes included health-related quality of life, and secondary outcomes included muscle strength, aerobic capacity, lung function, physical activity, and fatigue.	Significant differences were observed between groups only for muscle strength, peak expiratory flow, and exercise activity after three months. E-learning did not affect health-related quality of life but muscle strength, lung function, and physical activity.	6 months (3 and 6 months after intervention)	9

MS: Multiple sclerosis; VR: Virtual reality.

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Telerehabilitation approaches

Telerehabilitation approaches were divided into four categories of studies. Of the 16 studies, 4(25) used home-based exercise programs by web-based platforms [6, 16, 17, 24], 2(12.5) used sports counseling and physiotherapist support via telephone calls [21, 22], 3(19) used game [13, 18, 26], and 6(37.5) used virtual reality [12, 14, 19, 20, 23, 25].

Effects of telerehabilitation on physical activity and quality of life

In 6 studies, no significant differences were reported between conventional (face-to-face) physiotherapy versus telerehabilitation approaches in improving participants' performance [15-17, 21, 22, 24]. However, they reported that telerehabilitation is at least as effective as conventional care (face-to-face). In 12 studies, the results showed significant performance improvement, reduced fatigue, improved physical activity, and general balance in the telerehabilitation approach [6, 12-14, 18-24, 26]. Telerehabilitation programs as an alternative to treatment are good options to facilitate patient education [6, 18, 24, 26]. Furthermore, of the 16 included studies, 5 (31) studies reported an improvement in individuals' QoL [15-17, 22, 23], two of which showed a significant improvement in the individuals' QoL in the intervention group compared to the control group [17, 23].

Discussion

Principal findings

The objective of this review was to systematically evaluate the effect of telerehabilitation on improving physical activity, physical function, and QoL in individuals with MS. This review identified 16 studies that met all mentioned eligible criteria. All included studies were RCTs that evaluated the use of telerehabilitation in individuals with MS. According to the JBI checklist, the quality of studies from approximately all studies was moderate. Most included studies using virtual reality programs instead of traditional, face-to-face specialist visits. Other telerehabilitation interventions included web-based platforms, telephone calls, and smartphone-based games. Our study's findings showed that in most studies, there was a significant improvement in physical activity, performance, and self-efficacy in the telerehabilitation group versus the control group (in-person rehabilitation). Physical activity training can help improve balance and control individuals' condition [6, 12-14, 18-24, 26]. Furthermore, the studies showed a significant improvement in the individuals' QoL in the intervention group compared to the control group [17, 23].

Telerehabilitation shows effective outcomes using the tool for educating and following the treatment process in MS individuals. It increased the motivation and attraction of individuals [6, 18, 24, 26]. Ortiz-Gutiérrez et al., in examining the effect of virtual reality programs compared to traditional or face-to-face interventions in improving the balance and functional status of individuals from the three factors of increasing the level of practice in a distributed manner, increasing the repetition of functional tasks and activating the processes of integrating sensory information as the principle used for the treatment of stability disorders in individuals with MS. Their results showed that virtual reality game led to the improvement of the individual's functional status and improvement in balance [12]. In addition, Yazgan et al. reported that the better performance improvement in the telerehabilitation group was probably due to the effort to control balance in a wider range of motion during Nintendo games [23]. In contrast, Paul et al. reported that daily exercise notes may have been effective in strict adherence to the rehabilitation program. They also stated that special strategies are needed to interact with people without diary entries [17]. Molhami et al. reported that in the virtual reality-based telerehabilitation group, the speed of movement was imposed by an external agent, and participants had to react as quickly as possible to complete their tasks successfully. In contrast, in the group that practiced speed control, this speed was self-selected, and their control was their responsibility [19].

Also, Norouzi et al. stated that although telerehabilitation has positive effects in improving exercise on motor control of women with MS, mental and physical barriers prevent them from participating in physical exercises in daily life. In addition to motor and sensory problems, psychological problems have also been reported for women with MS. Virtual reality-based telerehabilitation offers a way to overcome these mental and psychological barriers [20].

Consistent with the results of our review, in their systematic review, Block et al. aimed to examine the progress and gaps in telemonitoring of physical activity in neurological diseases and concluded that telemonitoring of physical activity in neurological diseases is possible and safe in individuals with moderate to severe neurological disability. In addition, telemonitoring can be psychometrically suitable and responsive way to evaluate physical activity in neurological diseases [27].

Table 2. Characteristics of participants in all included studies

1st Author, Year, Country	Number of Participants	No. (%)		%
		Gender	MS Type	Age (y)
Ortiz-Gutiérrez et al. 2013, Spain [12]	Total: 47 Control: 23 Intervention: 24	Intervention Women: 13(54.2) Men: 11(45.8) Control Women: 14(60.9) Men: 9(9.1)	PP: 7(14.89) RR: 31(65.95) SP: 9(19.14)	Control: 42.78 Intervention: 39.69
Cuesta-Gómez et al. 2020, Spain [13]	Total: 30 Control: 14 Intervention: 16	Control Men: 5(35.71) Women: 9(64.28) Intervention Men: 7(43.75) Women: 9(56.25)	RR: 11(36.66) SP: 13(43.33) PP: 6(20)	Control: 42.66 Intervention: 49.86
Lozano-Quilis et al. 2014, Spain [14]	Total: 11 Control: 5 Intervention: 6	Intervention Men: 3(50) Women: 3(50) Control Men: 4(80) Women: 1(20)	Not mentioned	Control: 40.60 Intervention: 48.33
Waliño-Paniagua et al. 2019, Spain [15]	Total: 16 Control: 8 Intervention: 8	Intervention Men: 4(50) Women: 4(50) Control Men: 4(50) Women: 4(50)	Not mentioned	Control: 46.13 Intervention: 46.75
Paul et al. 2014, UK [16]	Total:30 Control:15 Intervention:15	Control Men: 3(20) Women: 12(80) Intervention Men: 3(20) Women: 12(80)	Benign: 2(6.66) PP: 4(13.3) RR: 17(56.6) SP: 5(16.6) Unknown: 2(6.66)	Control: 52.5 Intervention: 50.8
Paul et al. 2019, UK [17]	Total: 90 Control: 40 Intervention: 45	Control Men: 3(7.5) Women: 37(92.5) Intervention Men: 13(28.8) Women: 32(71.1)	Benign: 1(1) PP: 16(18) SP: 31(34) RR: 30(33) Unknown: 12(13)	Control: 55.6 Intervention: 56.5
Robinson et al. 2015, UK [18]	Total: 56 Control: 17 Intervention: 39	Control Men: 5(29.41) Women: 12(70.58) Intervention Men: 13(33.33) Women: 26(66.66)	Not mentioned	Control: 51.9 Intervention: 52.6
Molhemi et al. 2021, Iran [19]	Total: 39 Control: 20 Intervention: 19	Control Men: 8(40) Women: 12(60) Intervention Men: 7(36.84) Women: 12(63.15)	RR: 30(76.92) SP: 9(23.07)	Control: 41.6 Intervention: 36.8
Norouzi et al. 2021, Iran [20]	Total: 45 Control: 15 Intervention 1: 15 Intervention 2: 15	Not Mentioned	Not mentioned	Control: 26.39 Intervention: 26.42
Conroy et al. 2017, USA [21]	Total: 24 Control: 8 Intervention: 16	Control Men: 3(37.5) Women: 5(62.5) Intervention Men: 9(56.25) Women: 7(43.75)	RR: 6(25) SP: 17(70.83) PP: 1(4.16)	Control: 50.4 Intervention: 58.2

1st Author, Year, Country	Number of Participants	No. (%)		%
		Gender	MS Type	Age (y)
Plow et al. 2019, USA [22]	Total: 208 Control: 69 Intervention 1: 69 Intervention 2: 70	Control Men: 11(15.9) Women: 58(84.1) Intervention 1: Men: 14(20.3) Women: 55(79.7) Intervention 2: Men: 7(10.0) Women: 63(90.0)	RR: 176(84.6) SP: 11(5.3) PP: 6(2.9) PR: 1(0.5) Unknown: 14(6.7)	Control: 51.8 Intervention 1: 53.2 Intervention 2: 51.2
Yazgan et al. 2019, Turkey [23]	Total: 42 Control: 15 Intervention 1: 15 Intervention 2: 12	Control Men: 2(13.3) Women: 13(86.7) Intervention 1: Men: 2(13.3) Women: 13(86.7) Intervention 2: Men: 0(0) Women: 12(100)	RR: 33(78.57) SP: 2(4.76) PP: 1(2.38) PR: 6(14.28)	Control: 40.66 Intervention 1: 47.46 Intervention 2: 43.08
Hermens et al. 2008, Netherlands [24]	Total: 81 Control: 26 Intervention: 55	Men: 47(58.02) Women: 34(41.97)	Not mentioned	Control: 50.11 Intervention: 46.5
Peruzzi et al. 2016, Italy [25]	Total: 25 Control: 11 Intervention: 14	Control Men: 4(57.14) Women: 7 (63.63) Intervention Men: 6(42.85) Women: 8(57.14)	Not mentioned	Control: 42.0 Intervention: 43.6
Novotna et al. 2019, Czech Republic [26]	Total: 39 Control: 16 Intervention: 23	Control Men: 4(25) Women: 12(75) Intervention Men: 6(26.08) Women: 17(73.91)	Not mentioned	Control: 42.56 Intervention: 39.39
Tallner et al. 2016, Germany [6]	Total: 126 Control: 67 Intervention: 59	Control Men: 17(25) Women: 50(75) Intervention Men: 15(25) Women: 44(75)	RR: 109(87) SP: 17(13)	Control: 40.7 Intervention: 40.9

Abbreviations: RR: Relapsing-remitting; SP: Secondary progressive; PR: Primary progressive.

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Similarly, Cortés-Pérez et al. aimed to investigate the effect of virtual reality-based therapy on fatigue, efficacy, and QoL in individuals with MS. They concluded that virtual reality-based therapy reduces fatigue and the effect of MS and improves QoL is effective in individuals with MS [28].

In summary, several studies have proven the effectiveness of telerehabilitation and mobile health interventions [29-47]. Telecommunication technologies appear to be highly effective benchmarks in the rehabilitation and support of MS individuals. Therefore, it would be useful to confirm the effectiveness of this promising rehabilitation treatment option and to conduct long-term studies involving large samples, including individuals with MS with severe and progressive disability.

On the other hand, previous systematic reviews (2015) have examined the effects of telerehabilitation in individuals with MS. However, no recent systematic review has focused on improving physical conditions resulting from telerehabilitation compared to traditional rehabilitation [7, 8]. Nevertheless, in systematic reviews, it is recommended to focus on consensus and gather evidence at one point to respond to the results, indicating that focus by creating a clear picture of the problem at hand.

Conclusion

The findings of this review showed that telerehabilitation services for individuals with MS care are comparable to or better than conventional services. Telerehabilitation is an effective educational tool to restore and maintain physical activity balance and improve QoL in individuals with MS. Future studies on the facilitators and barriers to its use are suggested to maximize the impact of telerehabilitation.

Study strengths and limitations

This review included only RCT studies to reduce evidence bias and provide reliable evidence. In addition, this study was the first systematic review to evaluate the effect of telerehabilitation focusing on improving functional status in individuals with MS.

One of the limitations of the present review was that only the physical and functional implications of telerehabilitation in individuals with MS were investigated; therefore, other self-management based on telerehabilitation in individuals with MS needs further investigation. In this study, only studies published in journals and scientific conferences were included. Therefore, the study did not include articles published in gray literature. Also, the included studies used different methods to measure telerehabilitation outcomes. Therefore, conducting a meta-analysis and examining the effect of these studies as a group was impossible.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Mashhad University of Medical Sciences (No.: IR.MUMS.REC.1400.296).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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Appendix 1. Preferred reporting items for systematic reviews and meta-analyses checklist

Section/Topic		No.	Checklist Item	Reported on Page (No.)
Title	Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
Abstract	Structured summary	2	Provide a structured summary including, as applicable, background, objectives, data sources, study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results, limitations; conclusions and implications of key findings; systematic review registration number.	1
Introduction	Rationale	3	Describe the rationale for the review in the context of what is already known.	2
	Objectives	4	Provide an explicit statement of questions being addressed regarding participants, interventions, comparisons, outcomes, and study design (PICOS).	2
Methods	Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g. Web address), and, if available, provide registration information, including registration number.	N/A
	Eligibility criteria	6	Specify study characteristics (e.g. PICOS, length of follow-up) and report characteristics (e.g. years considered, language, publication status) used as criteria for eligibility, giving rationale.	3
	Information sources	7	Describe all information sources (e.g. databases with coverage dates, contact with study authors to identify additional studies) in the search and the date last searched.	3
	Search	8	Present a full electronic search strategy for at least one database, including any limits used so that it could be repeated.	3
	Study selection	9	State the process for selecting studies (i.e.screening, eligibility, included in a systematic review, and, if applicable, included in the meta-analysis).	3-4
	Data collection process	10	Describe the data extraction method from reports (e.g. piloted forms, independently, in duplicate) and any processes for obtaining and confirming investigator data.	3
	Data items	11	List and define all variables for which data were sought (e.g. PICOS, funding sources) and any assumptions and simplifications made.	5-9
	Risk of bias in individual studies	12	Describe methods used for assessing the risk of bias in individual studies (including specification of whether this was done at the study or outcome level) and how this information will be used in any data synthesis.	3
	Summary measures	13	State the principal summary measures (e.g. risk ratio, difference in means).	N/A
	Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g. I^2) for each meta-analysis.	N/A
	Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g. publication bias, selective reporting within studies).	N/A
	Additional analyses	16	Describe methods of additional analyses (e.g. sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A

Section/Topic		No.	Checklist Item	Reported on Page (No.)
Results	Study selection	17	Give the number of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	4
	Study characteristics	18	For each study, present characteristics for which data were extracted (e.g. study size, PICOS, follow-up period) and provide the citations.	5-9
	Risk of bias within studies	19	Present data on the risk of bias of each study and, if available, any outcome level assessment (see item 12).	6-9
Results	Results of individual studies	20	For all outcomes considered (benefits or harms), present for each study: (a) simple summary data for each intervention group, (b) effect estimates and confidence intervals, ideally with a forest plot.	5-9
	Synthesis of results	21	Present results of each meta-analysis, including confidence intervals and consistency measures.	N/A
	Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
	Additional analysis	23	Give results of additional analyses, if done (e.g. sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
Discussion	Summary of evidence	24	Summarize the main findings, including the strength of evidence for each primary outcome; consider their relevance to critical groups (e.g. healthcare providers, users, and policymakers).	9-10
	Limitations	25	Discuss limitations at the study and outcome level (e.g. risk of bias) and review level (e.g. incomplete retrieval of identified research, reporting bias).	10
	Conclusions	26	Provide a general interpretation of the results in the context of other evidence and implications for future research.	10
Funding	Funding	27	Describe funding sources for the systematic review and other support (e.g. supply of data); role of funders for the systematic review.	11

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