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The effectiveness of telerehabilitation on independence, balance, disability and function in stroke patients: A meta-analysis of randomized controlled trials

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Abstract

Objective: To determine whether the use of telerehabilitation leads to improved independence, balance, and quality of life, reduces disability, and enhances the function to perform activities of daily living among stroke survivors compared with usual care. *Methods:* This is a meta-analysis of randomized controlled trials that have been conducted. Relevant published studies from inception to November 2022 were retrieved from Embase (Ovid), the Cochrane Central Register of Controlled Trials, PubMed, Web of Science, CINAHL, CBM, VIP, CNKI and Wanfang. The literature search and data extraction processes were conducted by two independent authors. The methodological quality of the included studies was assessed by the Cochrane Risk-of-Bias Assessment Tool, version 2. The data analysis was performed using Review Manager (Version 5.4). *Results:* Ten randomized controlled trials published between 2009 and 2022 were included in this meta-analysis. Most of the studies were assessed as having some concerns. The certainty of the evidence in this review varied across outcomes, ranging from low to high. The meta-analysis showed statistically significant effects of tele-rehabilitation on function (standardized mean difference (SMD)=1.05, 95% confidence interval (CI): 0.42 to 1.67, P = 0.44), balance((SMD)= 0.88, 95% CI: 0.25 to 1.51, P = 0.20). However, no statistically significant effect on disability, independence and quality of life were found in our review.
Conclusions: Telerehabilitation may be effective for improving functional outcomes and balance among adult stroke patients, but the effect on disability, independence and quality of life is nonsignificant. More randomized controlled trials with larger sample sizes, more follow-up times, and rigorous study designs should be further conducted to identify the effect of Telerehabilitation on stroke patients.

Keywords: Telerehabilitation, stroke, independence, balance, disability, function, quality of life

INTRODUCTION

Stroke is one of the most common causes of death and acquired disability worldwide.[1] Survivors of stroke commonly experience a range of symptoms affecting motor function, swallowing, sensation and cognition, and recovery can be slow and incomplete.[2,3] These symptoms often lead to difficulty managing activities. Rehabilitation, as an indispensable part of stroke patient management, are often lengthy and resource difficulty in obtaining. Therefore, determining the most effective and efficient ways to deliver stroke rehabilitation services is a matter of priority.

Telerehabilitation is the provision of rehabilitation services to patients at a remote location using information and communication technologies.[4] Communication between the patient and the rehabilitation professional may occur through a variety of technologies such as the telephone, Internet based videoconferencing and sensors (such as pedometers). One of the key advantages of telerehabilitation is that it provides the opportunity for people who are isolated to access rehabilitation services. This feature is particularly beneficial during Covid-19, and is also likely to be beneficial in low resource settings where access to health professionals is poor. Stroke survivors have expressed concern regarding the lack of available long-term support and ongoing unmet rehabilitation needs.[5] It is possible that

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the use of telerehabilitation may help to address these gaps by supporting patients as they resume life roles on discharge from inpatient facilities.

There are several published meta-analysis on telerehabilitation of stroke patients[6,7], but no meaningful conclusions have been drawn. Given the growth of research in this area and the potential for telerehabilitation to improve access to, and quality of, telerehabilitation services while reducing costs, it is necessary to update the research results in this field. The aim of this present review is to compare the effects of telerehabilitation and usual care on people with stroke about balance, disability, quality of life, independence and function. The findings of this review can aid the government and policymakers in better allocating health care resources, foster the development of telerehabilitation programs during and beyond the COVID-19 pandemic, and improve the quality of rehabilitation services.

METHODS

This review was reported in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis.[8] The protocol has been registered with the registration number CRD42022378313 at PROSPERO (https://www.crd.york.ac.uk/prospero/#recordDetails)

Data sources and search strategies

Relevant studies published from inception to November 2022 were retrieved from PubMed and eight electronic databases including Embase (Ovid), the Cochrane Central Register of Controlled Trials, Web of Science, CINAHL, CBM, CNKI, VIP and Wanfang. The PICOS principle (participants, intervention, comparison, outcome, and study design) was performed to develop the search strategy. Medical subject headings (MeSH terms), keywords and Boolean operators were used to search studies, and keyword, title. Abstract terms were also used for supplementation. The search terms used in this review included stroke, cerebrovascular accident, vascular accident, telerehabilitation, telecommunications, remote consultation, telemedicine, electronic mail, computers et al, and the retrieval results were limited to RCTs. All of the search terms were pilot-tested and validated by independent researchers. Additionally, we searched the reference lists of the original literature manually for additional studies. Search strategies and specific details are presented in Supplementary Material 1.

Eligibility criteria

The inclusion criteria were as follows: (1) the participants of the studies were adult patients (≥18 years old) diagnosed with stroke; (2) studies using telerehabilitation intervention; (3) studies compared telerehabilitation intervention with usual care; (4) the study outcomes were at least one of independence, balance, disability, quality of life and function; (5) the study design was RCTs or pilot RCTs; and (6) the languages were English or Chinese. We excluded studies that pertained to (1) repeat published studies; (2) conference proceedings and abstracts, study protocols, letters, discussions or editorials; and (3) studies that provided incomplete data and no returns after contacting authors.

Study selection

We imported all the citations into the reference management program Endnote X9 for bibliography management and eliminating duplicates. Two authors (Wang and Cao) independently screened the retrieval results by titles and abstracts and then downloaded and carefully read the full-text articles to find eligible studies that met our inclusion criteria. Studies with ambiguous eligibility were discussed with a third author (Feng)when necessary.

Data extraction

The data extraction was performed by the same two independent authors using a self-designed Excel spreadsheet, including the study author, publication year, country, sample size, mean age, intervention and control methods, duration of intervention and follow-up, quantitative outcomes, assessment tools and results. If the necessary data were not reported in the articles, we contacted the study authors by email. Disagreements of the results were discussed with a third author (Feng) when necessary.

Risk of bias assessment

The risk of bias assessment of the included studies was conducted by Wang and Cao based on the Cochrane Risk-of-Bias Assessment Tool, version 2, recommended by the latest Cochrane Handbook.[9] The following domains were assessed: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reporting results. The reporting bias was assessed through published protocol or registration. Response

options from low risk of bias, some concerns to high risk of bias, the study was judged to be of low bias only when all the domains were assessed as low risk of bias. Disagreements were resolved through discussion, and a third author (Feng) helped if necessary.

Statistical analysis

In this review, we identified independence, balance and function as primary outcomes and the secondary outcomes were disability and quality of life. The results of the meta-analysis were performed using ReviewManager5.4 recommended by The Cochrane Collaboration, 2020. The mean differences (MDs) with 95% confidence intervals (CIs) were used as combined effects to calculate the pooled intervention effect, and the standardized mean differences (SMDs) with 95% CIs were used if the results of the included studies were assessed by different tools. According to the Cochrane Handbook,[9]the standardized mean difference equals the effect size. The effect size was estimated to be small, medium, and large when the Hedges' g was estimated as 02-0.5, 0.5-0.8, and more than 0.8. [10]Heterogeneity tests were assessed by I2 statistics (range from 0% to 100%) and P values. If the P value <0.5 and I2 > 50%, the result was assessed to have statistical heterogeneity, and a random effects model was used to conservatively estimate the pooled effects; otherwise, the fixed effects model was selected. We conducted a sensitivity analysis to test the reliability and stability of the results by excluding the included studies one by one and then recalculating the combined effects of the remaining studies. We did not perform the subgroup analysis or the publication bias assessment in this review because the number of included studies was small.[9]

RESULTS

Study selection

Two authors completed the study selection process independently. From the databases, a total of 118,275 records were retrieved. A total of 104,977 records remained after removing duplicates of 13,298 articles. Of these remaining records, 104,854 studies were excluded after preliminary selection by reading the titles and abstracts. In total, 123 studies were identified as possibly relevant studies and were assessed for eligibility, and 112 studies were excluded after full-text reading for the reasons presented in Figure 1. Finally, 10 RCTs[11-20] met our eligibility criteria were included in this meta-analysis.

Study characteristics

The characteristics of all the included studies are summarized in Table 1. The 10 RCTs studies were conducted in China (n = 3)[13,17,18], Singapore (n=1)[14], Italy (n=2)[11,19], the United States and Australia (n = 2)[12,15], and Spain (n = 2)[16,20], and they were published from 2009 to 2022.

Participants

There were 603 participants identified in the ten included studies who were randomly assigned to experimental groups (n =274) and control groups (n = 278), with sample sizes ranging from 11 to 62. All the participants were adult patients, and the mean ages ranged from 56.72±17.4 to 75.6±3.4. Six studies[11-13,15,19,20], described the time of stroke in the enrolled patients, ranging from 2 weeks to 32 months. One study [17] used National Institute of Health Stroke Scale scores (NIHSS) to evaluate the neurological impairment of the patients ranging from 2 to 20.

Intervention

The intervention approach was rehabilitation. Four studies[11,13-15] received a tele-rehabilitation system, including video conferencing online rehabilitation, rehabilitation education and consultation and assessment and therapy Functions. Two studies[16,20] through App as a telerehabilitation tool, and Grau-Pellicer *et al.*[16] creating a WhatsApp group to give motivation for active lifestyle, feedback to participants and to create a collective identity in the rehabilitation group. Two studies[18,19]prescribed a set of exercise video with QR code or VR image, and they had to perform the prescribed exercises under the guidance of the videos. Wu *et al*.[17] established a collaborative care team consisting of neurologists, nurses, rehabilitation therapists, counselors, and caregivers. Rehabilitation therapists assess the extent of patient dysfunction and work with family caregivers to develop rehabilitation plans and goals. Chumbler *et al*.[12] through home tele-visits to develop a treatment plan. Six studies[11,12,13,16,19,20] described the intervention time, duration ranging between 4 weeks and 12 weeks.

Comparison

Comparators varied in different studies; for ethical reasons, patients in the control group received

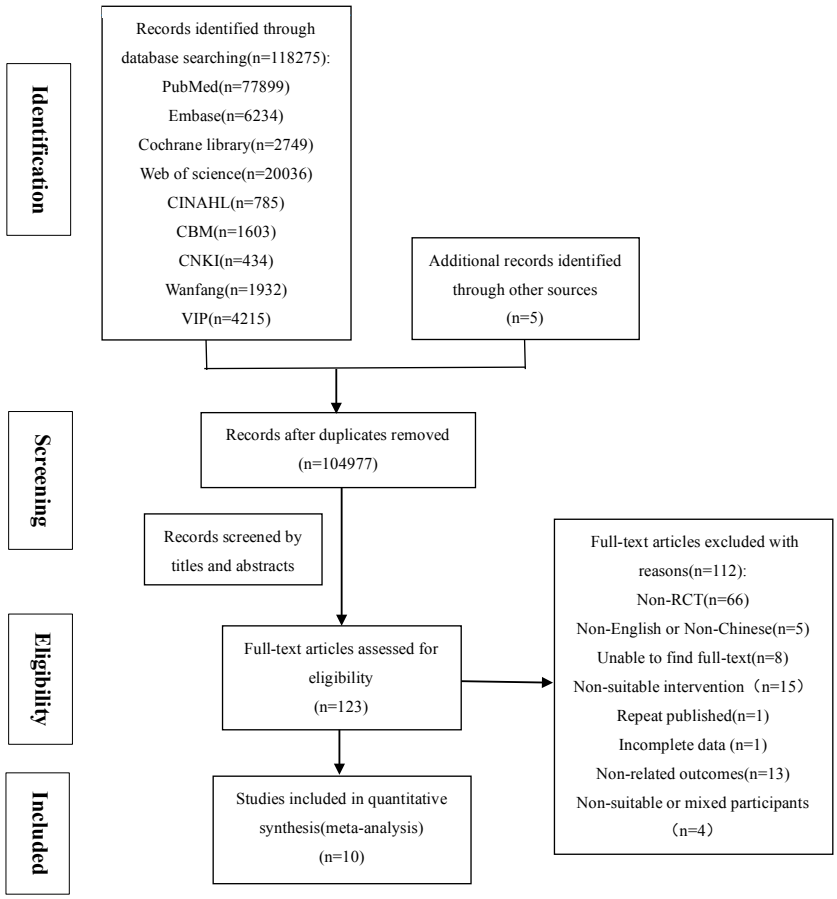


Figure 1. Flowchart of study selection and literature screening process.

routine rehabilitation and nursing measures at home, they can get rehabilitation instructions as needed. Among these studies, Cramer *et al*.[15] conducted their study at the research center.

Outcomes and assessment tools

All the assessment scales used in the outcome measurement were validated.

For the assessment of independence, four studies[13,14,16,17] were assessed using the Barthel index (BI). Among these studies, two studies[13,14] were assessed follow-up at 4th week; two studies[16,17] were assessed follow-up at 12th week.

For the assessment of balance, four studies[13,18,19,20] were assessed using the Berg Balance Scale (BBS), and Salgueiro *et al*.[20] used the Spanish-Trunk Impairment Scale (S-TIS) and the Spanish-Postural Assessment Scale for Stroke patient (S-PASS). Among these studies, Lin *et al*.[13] were assessed follow-up at 4th week; two studies[19,20] were assessed follow-up at 12th week; Wu *et al*.[18] were assessed follow-up at 4th week, 8th week and 12th week.

For the assessment of disability, two studies[12,14] were assessed using the Late-Life Function and Disability Instrument (LLFDI). Among these studies, Asano *et al*.[14] were assessed follow-up at 4th week; Chumbler *et al*.[12] were assessed follow-up at 12 week and 24th week.

For the assessment of quality of life, two studies[14,16] used the EuroQoL (EQ-5D), Wu et al.[18] used the Stroke-Specific Quality of Life Scale (SS-QOL). Among these studies, Asano et al.[14] were assessed follow-up at 4th week; Grau-Pellicer *et al*.[16] were assessed follow-up at 4th week, Wu *et al*.[18] were assessed follow-up at 4th week, 8th week and 12th week.

For the assessment of function, three studies[11,15,18] used the Fugl-Meyer Motor Function Assessment. Jonsdottir *et al*.[19] used the Box and Block Test (BBT), Bryan *et al*.[17] used the Modified Functional Ambulatory Category (MFAC), Chumbler *et al*.[12] used the Late-Life Function and Disability Instrument (LLFDI): function component. Among these studies, three studies[15,17,19] were assessed follow-up at 12th

week, Piron *et al*.[11] were assessed follow-up at 4th week and 8th week, Wu *et al*.[18] were assessed follow-up at 4th week, 8th week and 12th week, Chumbler *et al*.[12] were assessed follow-up at 12th week and 24th week.

Risk of bias

The Cochrane Risk of Bias Assessment Tool, version 2 was used by two authors independently to assess the methodological quality of the included studies. The results are shown in Figure 2. Specifically, all the included studies were reported as randomized, but selective bias existed because one studies did not mention allocation concealment. Due to the nature of rehabilitation interventions, blinding was not all possible, only five study used a blind method in the intervention process and studies were assessed as having some concerns in the deviations from intended interventions. In addition, three studies reported incomplete data and contributed to a high risk of attrition bias. Four studies were blind to outcome assessors and the other seven studies were concerned with bias in outcome measurement. Moreover, one study's reporting was selective, and three studies provided insufficient information to permit judgment and might cause an overestimated effect and introduce selection bias of the reporting results. Finally, one study was assessed as "low-risk bias", four studies were assessed as having "some concerns", and five studies were assessed as "high-risk bias". However, due to the possible death, deterioration, and dropout of participants, the missing data seemed inevitable and these high-risk studies were still included in this review.

Results of the meta-analysis

Effect of telerehabilitation on independence

Four studies[13,14,16,17] tested the effect of telerehabilitation on independence in stroke patients, including 219 participants, 113 in the intervention groups and 106 in the control groups. The overall combined results of our meta-analysis revealed a small effect size, and that telerehabilitation was not statistically significant in improving the overall independence score for stroke patients at postintervention (SMD=0.15, 95 CI%: –0.77 to 1.07, Z=0.32, P<0.0001), see Figure 3 (a).

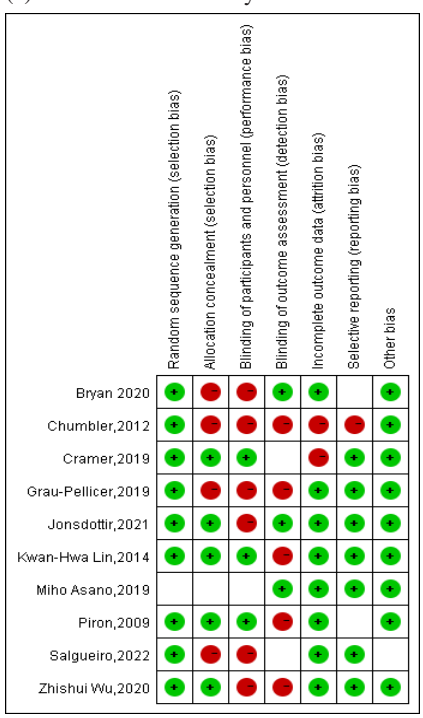
Effect of telerehabilitation on balance

Four studies[13,18-20] tested the effect of telerehabilitation on balance in stroke patients, including 149 participants, 68 in the intervention groups and 81in the control groups. The combined effects reflected that the effect size was large, and that telerehabilitation was statistically significant in improving the overall balance score for stroke patients at postintervention (SMD=0.88, 95 CI%: 0.25 to 1.51, Z=2.73, P=0.20), see Figure 3 (b).

Effect of telerehabilitation on disability

Two studies[12,14] tested the effect of telerehabilitation on disability in stroke patients, including 146

(a) Risk of bias summary



(b) Risk of bias graph

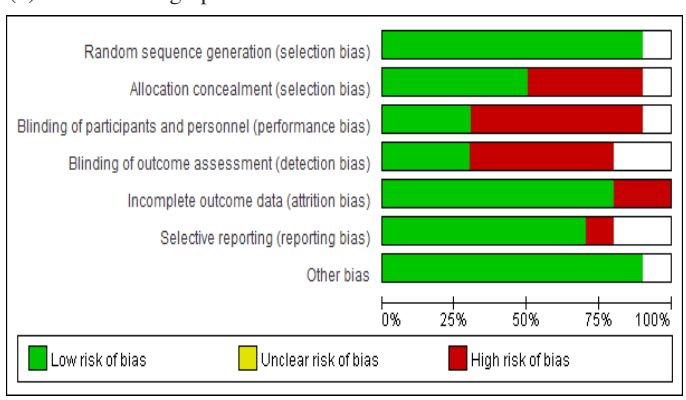


Figure 2. The results of risk of bias assessment of included studies.

participants, 75 in the intervention groups and 71 in the control groups. The overall combined results of our meta-analysis revealed a small effect size, and that telerehabilitation was not statistically significant in improving the overall disability score for stroke patients at postintervention (SMD= -0.07, 95 CI%: −0.48 to 0.34, Z=10.34, P=0.15), see Figure 3 (c).

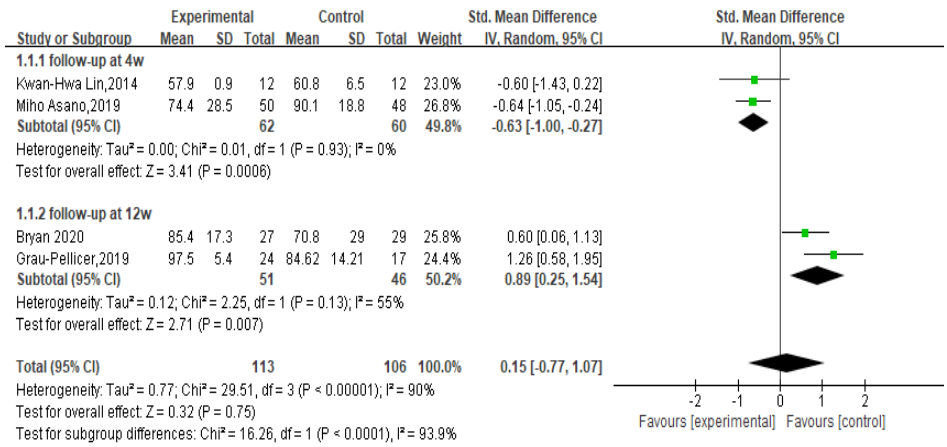
Effect of telerehabilitation on quality of life

Three studies[14,16,18] tested the effect of telerehabilitation on quality of life in stroke patients, including 200 participants, 104 in the intervention groups and 96 in the control groups. The overall combined results of our meta-analysis revealed a large effect size, but that telerehabilitation was not statistically significant in improving the overall quality of life score for stroke patients at postintervention (SMD=1.40, 95 CI%: –0.47 to 3.27, Z=1.47, P=0.04), see Figure 3 (d).

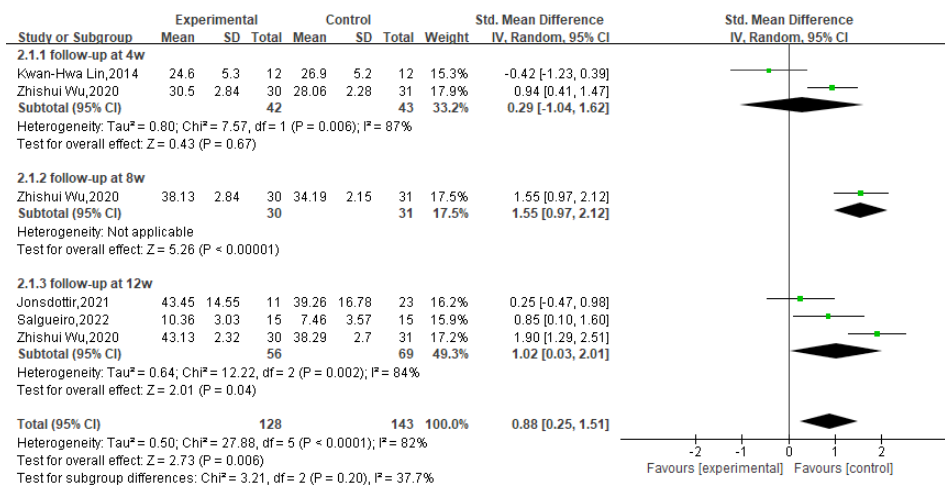
Effect of telerehabilitation on function

Six studies[11,12,15,17-19] tested the effect of telerehabilitation on function in stroke patients, including 359 participants, 173 in the intervention groups and 186 in the control groups. The overall combined results of our meta-analysis revealed a large effect size, and that telerehabilitation was statistically significant in improving the overall functional score for stroke patients at postintervention (SMD=1.05, 95 CI%:0.42 to 1.67, Z=3.29, P=0.44), see Figure 3 (f).

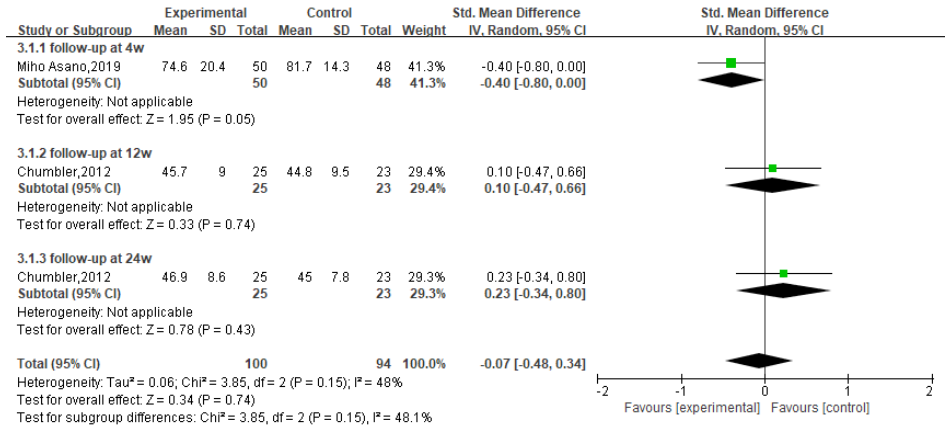
(a) independence



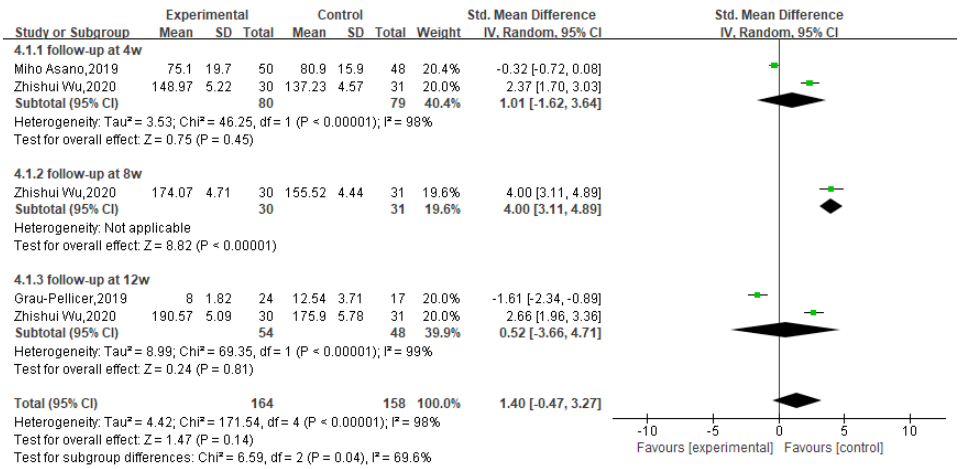
(b) balance



(c) disability



(d) quality of life



(e) function

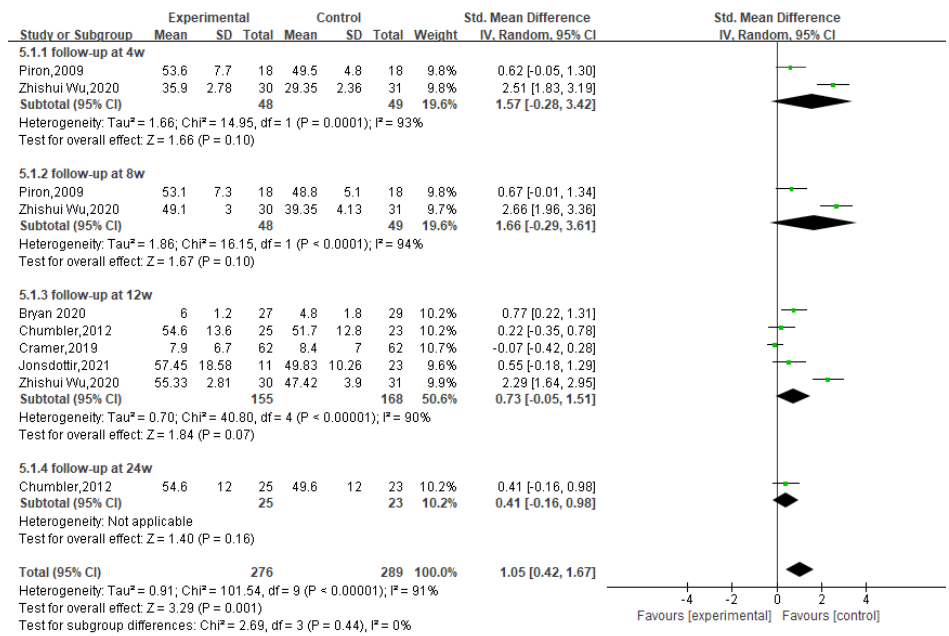


Figure 3. Forest plot of the effectiveness of telerehabilitation on: (a)independence; (b) balance; (c) disability; (d) quality of life; (e) function.

Table 1: Characteristics of the included studies

Study author, year, country	No. of participants (experimental/ control)	Age (years, experimental/ control)	Control	Experimental		Follow-up times	Outcomes and measurements	Results
				Inter-vention	Duration of intervention			
Piron[11], 2009, Italy	18/18	66.0±7.9/ 64.4±7.9	UC	TE	4th week	4th week/ 8th week	1. Functional: Fugl-Meyer 2. Spasticity of the arm: Ashworth scale.	No significant differences between groups.
Chumbler[12], 2012, US	25/23	67.1±9.5/ 67.7±10.0	UC	TE	12th week	12th week/ 24th week	1. Independence: FONEFIM; 2. Disability: LLFDI-disability; 3. Function: LLFDI-function.	No significant differences between groups.
Kwan-Hwa[13] Lin, 2014, China	12/12	74.6±2.3/ 75.6±3.4	UC	TE	4th week	4th week	1.Blance: BBS; 2. Independence: BI; 3. Satisfaction: Self-made scale.	1. TE > UC: blance and Independence 2. No significant differences between groups: satisfaction
Cramer[15], 2019, US	62/62	62±14/ 60±13	UC	TE	4th week	12th week	1. Function: LLFDI-function component.	No significant differences between groups.
Grau-Pellicer[16], 2019, Spain	24/17	62.96±11.87/ 68.53±11.53	UC	TE	8th week	12th week	1. Independence: BI; 2. The Quality of Life: EQ-5D-5L.	TE > UC: Independence, The Quality of Life.
Miho Asano[14], 2019, Singapore	50/48	63.6/ 64.4	UC	TE	12th week	4th week	1. Disability: LLFDI; 2. Independence: BI; 3. The Quality of Life: EQ-5D.	No significant differences between groups.
Zhishui Wu[18], 2020, China	30/31	56.73±11.85/ 59.10±8.60	UC	TE	4th week	4th week/ 8th week/ 12th week	1. Function: Fugl-Meyer; 2. Blance: BBS; 3. The Quality of Life: SS-QOL.	TE > UC: Function, Blance, The Quality of Life.
Bryan[17], 2020, China	27/29	66.9±14.0/ 72.5±15.5	UC	TE	12th week	12th week	1. Independence: BI; 2. Functional: MFAC.	1. TE > UC: Functional 2.No significant differences between groups: Independence.
Jonsdottir[19], 2021, Italy	11/23	56.72±17.4/ 60.19±9.63	UC	TE	12th week	12th week	1. Functional: BBT; 2. Blance: BBS.	No significant differences between groups.
Salgueiro[20], 2022, Spain	15/15	57.27±14.35/ 64.53±9.40	UC	TE	12th week	12th week	1. Blance: BBS; S-TIS; S-PASS.	No significant differences between groups.

UC=usual care, TE= telerehabilitation, Fugl-Meyer=Fugl-Meyer motor function assessment, FONEFIM = The motor subscale of the Telephone Version of the Functional Independence Measure, LLFDI=Late-Life Function and Disability Instrument, BBS= Berg Balance Scale , BI= Barthel Index, EQ-5D-5L:five-level EuroQol five-dimensional questionnaire, SS-QOL=The Stroke Specific Quality Of Life scale, MFAC=modified functional ambulation category scale, BBT= Box and Block Test, S-TIS= Trunk impairment scale, S-PASS= Postural Assessment Scale for Stroke Patients

DISCUSSION

Methodological quality of included studies

The methodological quality of the included studies was assessed by the Cochrane risk-of-bias tool, version 2. Most of the included studies were assessed as having some concerns or high-risk bias, and the summarized evidence across outcomes ranged from low to high. Specifically, due to the nature of telerehabilitation interventions, blinding was not all possible, only five study used a blind method in the intervention process, two studies reported incomplete data and contributed to a high risk of attrition bias, three studies were blind to outcome assessors and the other six studies were concerned with bias in outcome measurement and three studies provided insufficient information. Based on the findings, the studies included in this review did not obtain a high methodological quality.

Summary of main results

This study summarized data from ten RCTs with a total of 552 participants to investigate the impact of telerehabilitation on stroke patients. Comprehensive evidence showed that participants treated with telerehabilitation had ameliorative function and balance compared with control groups. However, the combined effect on the disability, independence and quality of life was not statistically significant.

Effect of telerehabilitation on balance

The results manifested a statistically significant effect of telerehabilitation on balance in patients with stroke. Neurological rehabilitation always focused to improve postural stability[21], evidence is growing for of the usability of telerehabilitation in neurological rehabilitation[22], similar to the results of this study. In stroke patients, it is reported that about 83% of stroke survivors suffering from balance impairment.[23] Balance impairment is charactered by short supporting time and differences between two sides of the body and slow walking speed, which may increase the risk of falls. Fear of falling can contribute to a sedentary lifestyle and increased disability, which means lower quality of life.[24] Falling often leads to longer hospital stay, more medical and nursing costs, and economic losses directly or indirectly. Thus, management of balance impairment is challenging for stroke patients. The separate meta-analysis in this review revealed a sustainable effect of telerehabilitation on balance at the 8th week after the intervention, which provided further evidence to popularize telerehabilitation in clinical practice. However, the methodological quality of balance was graded as moderate, and more high-quality studies should be further conducted to identify the effect of telerehabilitation in this field.

Effect of telerehabilitation on function

The results manifested a statistically significant effect of telerehabilitation on function in patients with stroke, consistent with a previous review.[25] The review[7] did not conduct a comprehensive effect analysis on functions, because the sample of two studies[11,15] included in the review were small; thus, evidence was insufficient to allow conclusions on whether the intervention was more effective than the comparison. However, our study included six studies[11,12,15,17-19] tested the effect of telerehabilitation on function in stroke patients, the comparable improvement in motor performance in the telerehabilitation and usual care groups was evident on all functional assessment scales; this adds to the reliability of our findings that telerehabilitation can produce significant motor improvements. As we know, the best treatment program is of little help to patients if they do not adhere to it, and so the telerehabilitation system was designed to maximize compliance.[26] In general, patient compliance with home-based physical therapy ranges from 23% to 64%[27], and after stroke, 65.3% of patients report adhering to at least part of a home exercise program.[28] The internet-based telerehabilitation mode has better rehabilitation continuity. Telerehabilitation mostly relies on electronic platform to promote patients' functional recovery by establishing a rehabilitation system suitable for functional recovery and combining specific task training with games.[18] It solves the inconvenience of patients going to the rehabilitation center, and provides opportunities for those whose movements are severely limited to obtain rehabilitation services. In a resource poor environment, telerehabilitation can also be used to supplement and improve the quality of existing rehabilitation services. In addition, telerehabilitation solves the problem that traditional methods cannot provide real-time feedback when training patients with functional tasks.[19] Remote rehabilitation in the form of video games is helpful to enhance the rehabilitation interest of stroke patients, which can not only improve the completion rate of training tasks, but also have a positive impact on the cognitive and psychological symptoms of stroke patients.[29]

Effect of telerehabilitation on independence

The results revealed no statistically significant effect of telerehabilitation on independence in patients with stroke, which was in line with previous reviews.[7,30] Telerehabilitation may be insufficient in helping stroke patients improve the overall independence, especially those with short terms. While Tyagi *et al*.[31] mentioned lots of patients difficult to adapt to telerehabilitation as a rehabilitation method as described in the study. The reason may be that the adaptation of remote devices took some time, and it did not show any advantages compared with usual care group. However, our study has suggested that longer follow-up times (>12 weeks) manifest statistically significant results in improving independence, which reflects that might telerehabilitation indicate a long-term or delayed benefit for patients with stroke. Thus, further studies are needed to explore the effectiveness of telerehabilitation on independence in stroke patients in different stages and the time-response relationship in this field. In addition, the grade of the evidence was of low certainty, and caution should be exercised in interpreting the results.

Effect of telerehabilitation on disability

The results manifested no statistically significant effect of telerehabilitation on disability in patients with stroke, which was in line with previous review.[7] Bryan *et al*.[17] found that telerehabilitation exercise program can't improve disability for patients recovering from stroke, comparing to standard exercise programs. It was suggested that disability is an essential concern in chronic stroke patients[32], and the first 6 month after stroke are of particular importance in recovery[33], the duration of rehabilitation programs and frequency of follow-up visits or contact with medical staff differed from a study to another. And from the forest plot, the separate effect of disability in stroke patients tends to improve gradually with the extension of follow-up time, thus, we cannot rule out the impact of follow-up time on our results. In addition, the included studies used different models of telerehabilitation. For example, some studies used only telephone calls[12], while others used educational videos[16,19], Web-based APP[16,18,20], and telerehabilitation systems.[11,13-15] So far, there are no adequate data in the literature about which model or telerehabilitation tool is optimal for these patients and thus future head-to-head comparative studies are advised.

Effect of telerehabilitation on quality of life

The findings on quality of life (QOL) shows the potential benefits of telerehabilitation interventions after stroke, but the pooled effect size was not statistically significant. The results of our review was consistent with previous studies.[6,7] Quality of life is a multidimensional perspective consisting of physical, psychological, spiritual and social aspects[34], that measure improved perception of QOL and improved mood are considered an important part of stroke rehabilitation.[35] Although the study[18] reported improvement in quality of life, we should also note that the other two studies[14,16] suggest that the quality of life of telerehabilitation in the intervention group is lower than the control group, neither study explained this result. The possible reason is that, telerehabilitation may indeed increase the anxiety and depression levels of patients due to inexperience in using technology.[36,37] In addition, concern for caregivers is also essential because several studies have shown high rates of depression and quality of life impairment among caregivers of stroke survivors, which negatively influences their supportive functions.[33,38] However, research on the caregiver's quality of life and interventions to improve their performance is not adequate. Therefore, confirming the value of telerehabilitation in this regard should be a focus of future studies, supplementing telerehabilitation with face-to-face consultations allows for more comprehensive assessments and physical examinations to be conducted[39], and encourage researchers to state which domains of the quality of life they intend to improve through the intervention.

Implications for research

Telerehabilitation, as a replacement for or, as an addition to, current therapies, the potential advantages are clear and have the potential to facilitate access to services (thereby improving equity). Our findings suggest that telerehabilitation may not be inferior to in person therapy and therefore appears to be a reasonable model of service delivery for people after stroke. At the same time, we also need to pay attention to that one of the possible factors that telerehabilitation have a more favourable outcome on balance and function because the rehabilitation focuses more specific towards physical and motor impairment, whereas impendence and disability involves a lot of other factors – cognition, language, mood, environmental and personal factors.

But it is worth our attention that, The

International Classification of Functioning, Disability, and Health (ICF) model, as a systematic approach to the provision of post-stroke rehabilitation, emphasizes activity and participation (ICF-A&P) as the core concepts of rehabilitation, the use of telerehabilitation has only recently emerged and is likely to become increasingly viable as information and communication technologies become more sophisticated and user friendly. While we focus on improving the balance and motor functions of stroke patients, we should also pay attention to how to improve patients' independence and reduce disability. How to build a systematic method for telerehabilitation after stroke? No one has given the answer yet. It is currently unclear which patient groups are most likely to benefit from telerehabilitation; It is also unclear which types of therapies are best suited to telerehabilitation. Therefore, more research in the form of adequately powered high-quality randomized controlled trials (RCTs) is urgently required.

There were several limitations in this review. a) Some limitations exist in the search strategy because we only included studies in English or Chinese; thus, some relevant studies might have been omitted and might influence the pooled results. b) Most of the studies in this review were assessed as having "some concerns" or "high-risk bias", causing a methodological flaw. In addition, with the influence of the mixed sample size, stroke types and stages, components of comparison interventions, assessment tools, and follow-up times, the heterogeneity across studies was high. As a result, the promotion of evidence might be limited, more RCTs had larger sample sizes and strict study designs should be further conducted. c) Because the number of included studies was small, we didn't perform the publication bias assessment, and a possible publication bias might exist in the results.

In conclusion, telerehabilitation may be effective for improving function and balance among adult stroke patients, but the effect on disability and independence is nonsignificant. More randomized controlled trials with larger sample sizes, multiple follow-up times, and strict study designs should be further conducted to identify the effect of Telerehabilitation on stroke patients.

Relevance to clinical practice

Telerehabilitation, as a replacement for or, as an addition to, current therapies, the potential advantages are clear and have the potential to facilitate access to services (thereby improving equity). Our findings suggest that telerehabilitation may not be inferior to in person therapy and therefore appears to be a reasonable model of service delivery for people after stroke. The use of telerehabilitation has only recently emerged and is likely to become increasingly viable as information and communication technologies become more sophisticated and user friendly. It is currently unclear which patient groups are most likely to benefit from telerehabilitation; for example, whether people living in remote areas may benefit and whether people that require enhanced support or rehabilitation on discharge or those many years post-stroke would benefit from a short-term program of rehabilitation. It is also unclear which types of therapies are best suited to telerehabilitation. Therefore, more research in the form of adequately powered high-quality randomized controlled trials (RCTs) is urgently required.

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DISCLOSURE

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