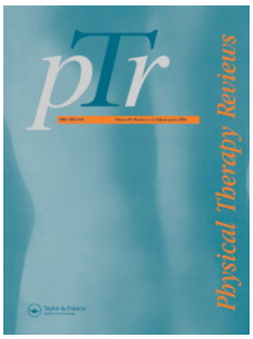

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Effectiveness of telerehabilitation on quality of life in stroke survivors: a systematic review and meta-analysis

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ABSTRACT

Background: Recent advances in technology have made possible the delivery of health services to patients remotely, and telerehabilitation for stroke survivors has emerged as a promising intervention. This systematic review assessed the clinical effectiveness of telerehabilitation (TR) programmes on quality-of-life (QoL) of stroke survivor compared to standard care.

Methods: MEDLINE, CINAHL, AMED, Web of Science, and Scopus databases were searched from inception to 10 June 2022. Studies were considered eligible for inclusion if they fulfilled the following criteria: assessed the efficacy of different telerehabilitation models in post-stroke patients, employed randomised controlled trial, and non-randomised design, stroke survivor adults age $\geq$ 18 years, health-related quality of life outcome, and full text available. Data were extracted by two independent researchers. Risk of bias was assessed by the Cochrane Handbook for Systematic Reviews of Interventions. A meta-analysis was performed among trials presenting with similar clinical characteristics.

Results: A total of 11 eligible studies that met the inclusion criteria were included in the review. These studies were conducted in Brazil ($n = 1$), Italy ($n = 2$), the Netherlands ($n = 1$), South Korea ($n = 1$), Taiwan ($n = 1$), United Kingdom ($n = 1$) and United States ($n = 4$) between 2004 and 2020. Except for blinding of participants to study group allocation, all the studies were (>50%) at low risk of bias to considering adequate sequence generation, allocation concealment, blinding of trial personnel or outcome assessors, evaluation of incomplete outcome data, and lack of selective reporting. The meta-analysis ($n = 5$) included 306 individuals with duration of follow-up ranged between 4 and 12 weeks. We found that there were no statistically significant difference (SMD = 0.089, confidence interval (CI) 95% = −0.184 to 0.362, $p = 0.522$) for Stroke Impact Scale between the interventions and the control.

Conclusion: The review provides evidence for the effectiveness of TR interventions to improve the QoL of stroke survivors in a short term. Further research studies are required to examine the effectiveness of TR interventions for stroke survivors in a long-term follow-up.

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Telehealth; telerehabilitation; telemedicine; quality of life; physiotherapy; stroke

Introduction

Stroke is one of the leading causes of mortality and a major cause of disability [1]. The most common consequences of strokes are communication disorders, physical impairments, mood disturbances, and cognitive and emotional problems [2]. Every year 15 million people suffer from stroke worldwide, and in the United Kingdom (UK), there are over 1.3 million stroke survivors [3,4]. Stroke creates considerable social and economic burden to individuals and society, for example, in 2017 stroke cost the 32 European countries under analysis €60 billion, with health care accounting for €27 billion (45%), representing 1.7% of healthcare expenditure [5]. From the societal perspective, the cost of stroke in 2014/2015 in the UK was £26 billion per year, including £8.6 billion NHS and social care costs [6]. Stroke has substantial adverse impact on the stroke survivors health-related QoL [7]. For example, a study that examined the national impact of stroke on health related QoL in the United States revealed that in addition to mortality and morbidity, stroke leads to significant reductions in quality of life [8].

Recent advances in technology have made possible the delivery of health services to patients remotely, and telemedicine for stroke survivors has emerged as a promising intervention [9]. This is in line with the World Health Organisation's health-

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for-all strategy recommendation to its member states to integrate the appropriate use of health telematics in their overall policy and strategy for the attainment of health for all in the 21st century [10]. Telemedicine is the exchange of healthcare through education and teaching programs from one location to another using electronic communication [11]. Telemedicine when used in rehabilitation is considered as telerehabilitation, and its use has rapidly grown worldwide [12]. Telerehabilitation can be defined as the ability to provide distance support to persons who are disabled via telecommunication, and its success depends mainly on the cooperation of patients and their families and rehabilitation team skills [13]. Telerehabilitation helps healthcare providers and patients to reduce hospitalisation times and associated costs [14].

Empirical evidence on the potential benefits of telerehabilitation for stroke survivors is needed to improve health-care delivery and outcomes. The findings of a recent systematic review indicated that telerehabilitation is comparable in effects to conventional in-person rehabilitation on health-related quality of life (QoL), upper extremity function, and balance function in poststroke patients [15,16]. However, the authors suggested further studies are needed to evaluate the health-related QoL on stroke survivors with the different components of the telerehabilitation that contributed to its effectiveness. This systematic review assessed the clinical effectiveness of telerehabilitation programmes on quality of life (QoL) of stroke survivors compared to standard care.

Methods

Search protocol and registration

This study was performed and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist for systematic reviews of intervention. A protocol for this systematic review was prospectively registered on PROSPERO and can be found at https://www.crd.york.ac.uk/PROSPERO/display_(CRD: 4202129 5888).

Data sources and search strategy

On June 10, 2022, a comprehensive search of the following databases: MEDLINE, CINAHL. Web of Science, Scopus, and Allied and Complementary Medicine Database (AMED) were performed. Final searches were conducted in January 2023. The searches were combinations of rehabilitation, stroke rehabilitation, exercise therapy, physical, rehabilitation medicine, physical rehabilitation, telehealth, mobile health units, telemedicine, remote monitoring, telerehabilitation, remote rehabilitation, virtual rehabilitation, quality of life, and health-related quality of life. The search was delimited to articles published in English language. References of the included studies were searched for any studies we missed during the database search.

Inclusion and exclusion criteria

Studies were considered eligible for inclusion if they fulfilled the following criteria: assessed the effectiveness and efficacy of different telerehabilitation models in poststroke patients, employed randomised controlled trial, and non-randomised design, adults (age $\geq$ 18 years) stroke survivor, health related quality of life outcome, and full text available. Health related quality of life was defined as an individual's perception of position of life in the context of the culture and value system, and it is measured by validated scales and measurement systems such as Stroke Impact Scale, European Quality of Life 5 Dimensions (EQ-5D), Short Form-12 and the Short Form-36 [17,18]. Telerehabilitation in this study include any alternative method that is useful to deliver therapy in a setting convenient to the patient using information and communication technology [19]. We excluded studies that had non-telerehabilitation therapies, treatment which was aimed specifically on children or animals, conference papers, case studies, and editorial. Two reviewers (TG and CM) screened the search results using the criteria mentioned above. When the judgments of both reviewers were not similar, other reviewers solved the discrepancy (CA and FF).

Study selection and assessment of methodological quality

Following removal of duplicates, one reviewer (TG) screened all titles, abstracts, and full-text articles and a sample of each was checked by a second reviewer (FF). Any difference was resolved by discussion and consensus with other reviewers (CM and CA). The full texts of the identified studies were checked against the inclusion and exclusion criteria. We used the Cochrane Handbook for Systematic Reviews of Intervention [20], to assess the methodological quality of each included studies. The criteria recommended in the Cochrane Handbook for Systematic Reviews of Interventions for randomised control trial include random sequence generation; allocation concealment; blinding of participants, clinical staff, and outcome assessors (performance bias, detection bias); incomplete outcome data (attrition bias); selective reporting (reporting bias); and other bias. To assess the methodological quality of the

observational studies, confounding, selection bias, information bias, bias due to deviations from intended interventions, bias due to missing data, bias in measurement of the outcome and bias in selection of the reported result were used. The overall risk of bias assessment of the included studies was reported as high (high risk of bias in at least one domain for the result), moderate (some concerns in at least one domain for the result, but not to be at high risk of bias for any domain), and low (low risk of bias for all domains for the result). Any difference was resolved by discussion and consensus with other reviewers.

Data extraction

Two independent reviewers (TG and CM) used Excel sheet to extract data for the prespecified outcomes, including author, country, setting, study design, numbers of patients randomised to each arm, population (*n*, % female), details on blinding, age, inclusion and exclusion criteria, intervention and control conditions, duration, outcome measures used and result of studies. Discrepancies were resolved by discussion with other reviewers (CA and FF) when necessary.

Data synthesis

Data synthesis was carried out using a descriptive and quantitative synthesis. The number of patients in each group who improved their health were recorded during follow-up period. Using a comprehensive meta-analysis software (Comprehensive Meta-Analysis v3 exe.), a summary of risk ratio of effects was calculated for some of the individual studies. To adjust for the heterogeneity across interventions, a random-effect model was adopted [21]. The assessment of heterogeneity was based on I^2 statistic, where 0% to 25% was low, 26% to 74% moderate and 75% and over were high statistical heterogeneity [21].

Results

The search strategy identified 1367 studies. After the removal of duplicates, 1076 studies were screened for title and abstract. 86 studies progressed to the next stage and were reviewed in full text. A total of 11 eligible studies that met the inclusion criteria were reviewed. The literature selection process is outlined in Figure 1.

Characteristics of the included studies

The study characteristics are outlined in Table 2. The 11 RCTs published between 2004 and 2020. The studies were conducted in a number of countries including Brazil ($n = 1$), Italy ($n = 2$), Netherlands ($n = 1$), South Korea ($n = 1$), Taiwan ($n = 1$), United Kingdom ($n = 1$) and United States ($n = 4$). The number of participants in any single study varied from 15 to 536 with a mean (SD) age of 43.7 (11.3) to 68 (11.9) years. The duration of follow-up ranged between 1 month and 12 months. While telerehabilitation was a common mode of delivery of interventions, the actual interventions that were delivered varied within the included studies (Table 1). The outcome measures reported are Stroke-Specific Quality of Life Scale, the Short Form 36 Health Survey Questionnaire (SF-36), self-rated quality of life questionnaire, the 12-Item Short Form Health Survey (SF-12), and European Quality of Life 5 Dimensions 3 Level Version (EQ-5D 3 L) [22–32].

Risk of bias assessment

Table 2 provides a summary of the risk of bias assessment of the included randomised control trial studies ($n = 11$). All the included studies reported low risk of bias in selection bias. Allocation concealments were reported in 54.6% ($n = 6$) of studies with a high risk of bias. 90% ($n = 10$) of the included studies (unclear risk of bias) reported blinding of participants to the study group allocation. On the other hand, 82% ($n = 9$) of the included studies (low risk of bias) reported blinding of trial personnel or outcome assessors. A low risk of bias with respect to attrition in 73% ($n = 8$) of the included studies was also reported. Selective reporting was reported in 55% ($n = 6$) of the studies with a low risk of bias.

Summary of key findings

Table 1 provides a summary of outcomes from the 11 included studies. Collectively, despite heterogeneity in the intervention parameters underpinning telerehabilitation and the varied measures of outcomes, it appears that it is more likely that telerehabilitation may be as effective compared to conventional therapy to improve health related QoL. Although some of the included studies [24,25,28,30–32] indicated a statistically not significant difference between the intervention and control, all of them seems to show improvements in health-related quality of life.

Random effects analysis was performed to calculate the risk ratio difference for health-related quality of life (Stroke Impact Scale) between

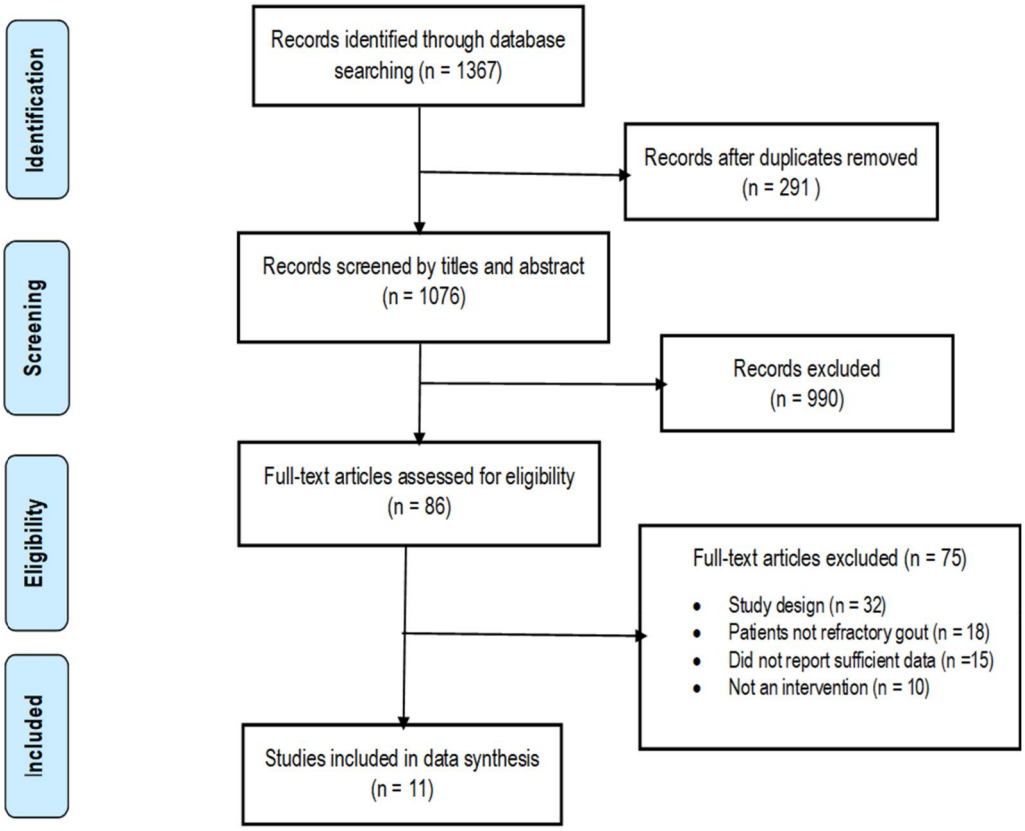

Figure 1. PRISMA flow diagram for included studies.

telerehabilitation and the controls (Figure 2). Telerehabilitation is an example of using information communication technology in the field of rehabilitation (Table 1). The meta-analysis included 306 individuals with duration of follow up ranged between 4 weeks and 12 weeks [24,26,28–30]. It found that there was no statistically significant difference (SMD = 0.089, confidence interval (CI) 95% = −0.184 to 0.362, $p = 0.522$) between the interventions and the control.

Discussion

To the best of our knowledge, our study is the first to perform a systematic review and meta-analysis on the effectiveness of telerehabilitation on QoL in stroke survivors. A total of 11 studies from eight countries were included. All the included studies were assessed low risk in selective bias. The results of this systematic review suggest that telerehabilitation is effective compared to standard care to improve for health related QoL in stroke survivors. However, the pooled analysis indicated that telerehabilitation interventions are as good as conventional rehabilitation in improving the QoL in stroke survivors. Small numbers of studies and the variety of telerehabilitation interventions included for meta-analysis could be the reason for the findings.

In line with our review, systematic review findings on the effectiveness of telerehabilitation in the management of adults with stroke and Multiple Sclerosis has suggested that telerehabilitation produced comparable improvement of the patients' health related QoL and activities of daily living function [33–35]. Overall, the current review provides positive results that suggests telerehabilitation is effective, adding to the findings of previous systematic reviews evaluating the efficacy of telerehabilitation in the management of stroke survivors [15,16,32]. However, it is necessary to underscore that telerehabilitation interventions have both advantages and disadvantages over face to face [36,37]. The advantages of telerehabilitation interventions may include improved access to information, provision of care not previously deliverable; improved access to services and increasing care delivery; improved professional education; quality control of screening programmes; and reduced healthcare costs [36]. On the other hand, several drawbacks limit the spreading of telerehabilitation: a breakdown in the relationship between health professional and patient; a breakdown in the relationship between health professionals; issues concerning the quality of health information; the lack of technological infrastructure in low-income countries, and organisational and bureaucratic difficulties [36,38]. Thus, regardless of the evidence on the

Table 1. Characteristics of the included studies.

Author/country	Setting	Population, (mean age)	Intervention	Control	Outcome measure	Duration of follow-up	Key findings
Wu et al. [22]/ Taiwan	Hospital	All, 64 (57.67 ± 10.22) Int, 32 (56.73 ± 11.85) Cot, 32 (59.10 ± 8.60)	-Patients received home remote rehabilitation based on a collaborative care model (consisting of neurologists, nurses, rehabilitation therapists, counsellors, and caregivers). -The same intervention as the control group during hospitalization was also provided.	Routine early rehabilitation guidance and nursing, the normal limb position, bed position transfer, joint activity maintenance training, dietary guidance, and medication guidance.	The Stroke-Specific Quality of Life Scale	12 weeks	-Both groups were significantly improved in terms of quality of life -The intervention group showed greater improvement in Quality of Life Scale (Int = 190.57 ± 5.09, Cot = 175.90 ± 5.78).
da Silva Ribeiro et al. [23]/ Brazil		All, 30 Int, 15 (52.8 (8.6)) Cot, 15 (53.7 (6.1)) Gender, Int, $M = 5$, $F = 10$ Cot, $M = 06$. $F = 09$ Time since stroke (months), mean (SD) Int = 60.4 (44.1) Cot = 42.1 (26.9)	-Virtual rehabilitation, treated in a room equipped with the NW and a multimedia projector. -The image was projected on the wall from the ground, and the UL, LL, and trunk muscles were stretched for 10 min. Subsequently, patients underwent a 50-min protocol of NW games. -During rehabilitation, patients had a 1-min rest interval between each game.	The conventional physiotherapy protocol consisted of two weekly sessions.	SF-36	8 weeks	The SF-36 scale analysis revealed a significant difference within both groups with regard to the following domains: physical functioning, role limitation due to physical aspects, vitality, and role limitation due to emotional aspects.
Cramer et al. [24]/ USA	Hospital	All, 124 Int, 62 (62 (14)) Cot, 62 (60 (13)) Gender, All $F = 34$ $M = 90$	-Intensive home-based telehealth -Internet-enabled computer with table, chair, and 12 gaming input devices' −18 supervised and 18 unsupervised 70-min sessions.	-Traditional in-clinic rehabilitation therapy −18 supervised and 18 unsupervised 70-min sessions. −18 unsupervised treatment sessions were at home, guided by an individualized booklet.	SIS	4 weeks	-Stroke Impact Scale scores increased by 23.7 ($p < 0.001$) in the telerehabilitation group and by 29.2 ($p < 0.001$) in the control group. -Int, mean (SD) 38.8 (26.3) -Cot, mean (SD) 42.6 (24.1)
Forducey et al. [25]/USA	Community	All, 9 (60 range 47 to 75) Int,4, Cot, 5 Gender, All $F = 6$, $M = 3$	Education sessions aimed at selfcare, mobility and posture delivered *via* desktop video phone using standard telephone lines.	Standard home care: the same with intervention but provided face to face.	SF-12	6 weeks	-Significant pre-post differences were found for both the videophone and standard of care treatment conditions on the FIM and SF-12 (all *ps* < 0.05).

(*continued*)

Table 1. Continued.

Author/country	Setting	Population, (mean age)	Intervention	Control	Outcome measure	Duration of follow-up	Key findings
							-No significant differences between Int and Cot.
Byl et al. [30]/USA	Community	All, 15 (59.3 (6.8)), Int 1 (physical), 5 Int 2 (Unilateral),5 Cot (bilateral), 5 All, $M = 12$, $F = 3$	Actual task specific repetitive training (TSRT) working with a physical therapist were scheduled for a 90 min appointment.	-Virtual TSRT guided by the wearable robotic orthosis (UL-EX07) used unilaterally -Virtual TSRT guided by UL-EX07 used bilaterally (BRO).	SIS	6 weeks	-Physical therapy, MD(SD) 6.5 (10.3) -Unilateral, MD (SD) −0.2 (11.25) -Cot, MD (SD) 1.8 (8.32) -Not statistically significant difference between the groups was observed.
Linder et al. [26]/ USA	Clinic	All, 99 Int, 51 (55.5 (12.6)) Cot, 48 (59.4 (13.6)) Gender Int $M = 31$ (60.8%) Cot, $M = 33$ (68.8%),	-A robot-assisted therapy and home exercise program using a telerehabilitation model. -It consisted of a total of 3 hr of use of the more affected upper-extremity, 5 days/week.	-A home exercise program. -Participants were asked to complete the prescribed activities and exercises using their affected upper extremity for a total of 3 hr/day, 5 days/wk.	SIS	12 weeks	-Int, mean (SD) 2 (5.9) -Cot, mean (SD) 1 (2.1) -Statistically significant difference was observed in both groups. -Participant in both groups improved significantly on the SIS domain scores.
Manuli et al. [27]/Italy	Community	All, 90 (43.7 ± 11.3 Int 1, 30 (48.0 ± 12.1) Int 2, 30 (40.1 ± 10.7) Cot, 30 (43.1 ± 9.7) Gender (M) Int 1 = 19 (63.3%) Int 2 = 6 (20.0%), Cot = 16 (53.3%)	Robotic rehabilitation group (RRG) undergoing robotic rehab with virtual reality (VR) and the robotic rehabilitation group only underwent 40 training sessions (i.e. five times a week for 8 weeks, each session lasting about 1 hr, besides 40 sessions of physiotherapy).	Conventional rehabilitation (CR), face-to-face approach between the therapist and the patient using pencil and paper tools. CR mainly focused on attention and executive and visuospatial skills.	SF-12	8 weeks	Only in the RRG + VR were observed a significant improvement in cognitive flexibility and shifting skills, selective attention, and quality of life, with regard to the perception of the mental and physical state.
Shin et al. [29]/ South Korea	Rehabilitation hospital	All, 46 Int, 24 (57.2 ± 10.3) Cot, 22 (59.8 ± 13.0) Gender, male Int = 19, Cot = 17 Time from stroke, months Int = 13.6 ± 13.4 Cot = 15.0 ± 14.6	-VR-based rehabilitation combined with standard occupational therapy (SOT) - A use of RAPAEL Smart Glove #-Four week face-to-face (20 sessions for 30 min per day) - SOTdaily for 30 min -Focused on the distal upper extremity and were administered by 3 trained occupational therapists	-Conventional rehabilitation - Four week face-to-face (20 sessions for 30 min per day) - SOT daily for 30 min. - Focused on the distal upper extremity and were administered by 3 trained occupational therapists	SIS	4 weeks	-Int, 518.3 ± 100.2 -Cot, 483.7 ± 28.7 -The improvements in the SIS scores were significantly greater in the Int group than in the Cot.

(*continued*)

Table 1. Continued.

Author/country	Setting	Population, (mean age)	Intervention	Control	Outcome measure	Duration of follow-up	Key findings
Boter et al. [31]/The Netherlands	General hospital	All, 536 Int, 263 (66¥ (52 to 76) Cot, 273 (63¥ (51 to 74)) Gender (F) Int = 133 (51%), Cot = 143 (52%)	The outreach care consisted of 3 nurse-initiated telephone contacts and a visit to the patients in their homes	Standard care	SF- 36	6 months	- Int had better scores on the SF-36 domain "Role Emotional" than Cot (MD = 7.9 [95% CI, 0.1 to 15.7]). - No statistically significant differences between the Int and Cot.
Saposnik et al. [28]/ Italy	Hospital	All, 22 Int, 11 (67.3 (46–83)) Cot, 11 (55.3 (41–72)) Gender, male Int = 7, Cot = 7	- Eight interventional sessions (VRWii or RT) of 60 min each over a 14-day period. -The eight sessions were scheduled in a flexible manner with sessions separated by $\geq$ 5 h.	Standard rehabilitation therapy (1 h of physiotherapy and another hour of occupational therapy per day).	SiS	4 weeks	Int potentially effective alternative than Cot. However, no significant differences were observed between them.
Adie et al. [32]/United Kingdom	Care home or hospital	All, 235 (67.3 ± 13.4)) Int, 117 (66.8 (14.6)) Cot, 118 (68.0 (11.9)) Gender (Female) Int = 51 Cot = 53	-The Nintendo Wii Sports™ (WiiTM) games (bowling, tennis, golf and baseball) to play. -The therapists installed the Wii™ and taught participants how to use it. - Instructed to exercise for up to 45 min daily for six weeks	-Participant-tailored arm exercises at home -Instructed to exercise for up to 45 min daily	Stroke Impact Scale & EQ-5D 3 L	6 weeks a 6 months	-Both groups showed an improved quality of life (EQ 5D) at follow-up. -No significant difference in quality of life at six months, between the two groups.

Note: Int: Intervention; Cot: Control; ¥: median age; MD: mean difference; SD: Standard Deviation; SF: Short Form; EQ 5D 3L: European Quality of Life 5 Dimensions 3 Level Version; SIS: Stroke Impact Scale; M: male; F: female; UL: upper limbs; LL: lower limbs; NW: Nintendo Wii; FIM: Functional Independence Measure.

Table 2. Risk of bias item presented as percentages across all included studies.

	Yes – low risk of bias	No – high risk of bias	Unclear
Random sequence generation (selection bias)	11 (100%)	0 (0%)	0 (%)
Allocation concealment (selection bias)	4 (36.4%)	6 (54.6%)	1 (9%)
Blinding of participants to study group allocation	1 (9%)	0 (0)	10 (91%)
Blinding of trial personnel or outcome assessors	9 (82%)	2 (18%)	0 (0%)
Incomplete outcome data (attrition bias)	8 (73%)	2 (18%)	1 (9%)
Selective reporting	6 (55%)	4 (36%)	1 (9%)

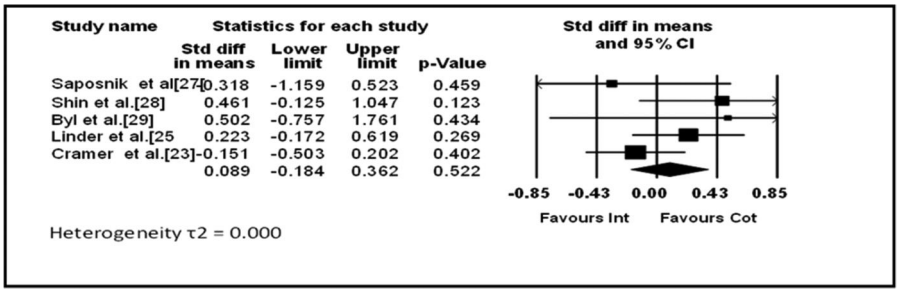

Figure 2. Forest plot for the effect of telerehabilitation on health-related quality of life outcomes in stroke survivors.

effectiveness of telerehabilitation, unequivocal recommendation cannot be made due to the variations of interventions and comparators across studies, and there were few adequately powered studies.

The included studies in the current review used different models of telerehabilitation interventions. Some studies used only telephone calls [31], while others used videophone [25], Nintendo Wii Sports [32], robot-assisted therapy [26], virtual reality systems [28], and a glove-shaped sensor device and a software application [29]. Moreover, the duration of telerehabilitation programmes and frequency of follow-up visits with medical staff differed from one study to another. Parallel to this it is important to put in place measures to ensure the safety of people with stroke during the implementation of telerehabilitations. Some of the measures used to prevent the adverse events of the stroke survivors may include simple telephone monitoring and synchronous therapist led sessions [39].

The included studies varied with participants age, duration of follow up, and the settings where they received the intervention. Except two [31,32], all the included studies included were conducted in participants below the 60 years. The reason for the researchers working with young adults could be due to their better use of information, communication and technology through mobile apps, computer system or electronic gadget [33]. Parallel to this, previous research has also confirmed that the age of the patients is important to determine the stroke care they receive [38]. The duration of follow up of the patients in the included studies varied between 1 months and 12 months. This variation could be due to some stroke patients requiring intensive rehabilitation in hospitals because of the severity of their condition compared to others in the community [33].

There are a number of strengths and limitations of this study that need to be considered. The main strength of this review is the comprehensiveness of the search terms, screening of numerous data bases, and assessment of methodological quality of the studies. We evaluated the pooled benefits of telerehabilitation interventions in stroke survivors' QoL in a meta-analysis. Only studies published in English language were included. Therefore, it is possible that relevant studies published in other languages may have been excluded. The relatively small sample size, small number of studies and the adoption of several different mode of telerehabilitation interventions in the included studies limit the generalisability of the findings. Despite these limitations, we believe that this review was systematic in nature and summarises all available and relevant results of the effectiveness of telerehabilitation on QoL in stroke survivors from the literature.

Conclusion

This is the first systematic review and meta-analysis that has exclusively evaluated the effectiveness of telerehabilitation on health related QoL in stroke survivors. The results of the current study do support that telerehabilitation interventions are a viable option compared to standard practice for stroke survivors. However, the review was unable to demonstrate the benefit of pooled effectiveness of telerehabilitation, and further rigorous clinical trials are warranted prior to formally concluding its effectiveness on the QoL in stroke survivors. If supported in future and better designed trials, telerehabilitation may become a striking alternative to standard practice to improve health outcomes at the least cost, by improving access to a timely

intervention and reducing inequities in the accessibility to stroke survivors.

Ethical approval

For this study ethical approval is not required. Note: Abstract for this study has already been published previously: https://e-space.mmu.ac.uk/631966/

Author contributions

All authors made substantial contributions to conception and design of the study. All authors interpreted the data, revised the draft critically and approved the submitted manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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