Received: 2 June 2021 | Revised: 1 September 2021 | Accepted: 9 November 2021

DOI: 10.1111/jocn.16142

Journal of Clinical Nursing WILEY

REVIEW

Effects of telehealth interventions on performing activities of daily living and maintaining balance in stroke survivors: A systematic review and meta-analysis of randomised controlled studies

Ita Daryanti Saragih MSN, RN, Predoctoral researcher[1] | Dame Elysabeth Tuty Arna Uly Tarihoran MSN, RN, Assisstant professor[2] | Sakti Oktaria Batubara MSN, RN, Doctoral Student[1] | Huey-Ming Tzeng PhD, RN, FAAN, Professor[3] | Chia-Ju Lin PhD, RN, Assisstant professor, Research member[1,4]

[1]College of Nursing, Kaohsiung Medical University, Kaohsiung, Taiwan

[2]School of Nursing Faculty of Medical and Health Sciences and Assistant Professor, School of Nursing, Krida Wacana Christian University, UKRIDA, Jakarta, Indonesia, University of Auckland, New Zealand

[3]University of Texas, Medical Branch, School of Nursing, Galveston, Texas, USA

[4]Department of Medical Research, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan

Correspondence
Chia-Ju Lin, Assistant Professor, College of Nursing, Kaohsiung Medical University, Kaohsiung, Taiwan and Research member, Department of Medical Research, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan.
Email: chiaju@kmu.edu.tw

Abstract

Background: Stroke is one of the most common causes of disability worldwide. In recent years, diverse telehealth programmes for stroke survivors have suggested that this mode of rehabilitation could improve stroke survivors' abilities to perform activities of daily living (ADLs) and maintain balance. Although increasingly utilised in clinical and community settings, the effectiveness of telehealth interventions in stroke survivors remains inconclusive. This warrants investigation so that telehealth interventions are evidence-based and are not merely modalities of convenience.

Aim: To identify the effects of telehealth interventions on the ability to perform ADLs and maintain balance in stroke survivors.

Design: A systematic literature review and meta-analysis were conducted in accordance with PRISMA guidelines.

Methods: A systematic literature search was performed using seven databases for literature dated up to April 25, 2021. The revised Cochrane risk of bias tool for randomised trials was used to assess the methodological quality of the included studies. A meta-analysis was performed using a random-effects model to calculate the pooled effects of telehealth interventions. Stata 16.0 was used for the statistical analyses.

Results: A total of 14 studies with 1,367 participants were included in the analysis. Overall, telehealth interventions were effective in improving stroke survivors' abilities to carry out their ADLs (standardised mean difference: .45; 95% confidence interval: .12 to .78); however, no significant effects were found on balance.

Conclusion: Telehealth interventions are beneficial for improving stroke survivors' performance of their ADLs. Future telehealth intervention trials should focus on identifying essential intervention delivery components that facilitate intervention adoption by clinicians and stroke survivors and sustain the positive effects on stroke survivors' performance of their ADLs in different settings.

Relevance to clinical practice.: It is essential to build flexibility in the telehealth-based intervention delivery protocol to meet individual stroke survivors' needs to motivate and enhance their ADL performance.

KEYWORDS
activities of daily living, balance, meta-analysis, stroke survivors, telehealth

1 | INTRODUCTION

Stroke is defined as a medical condition that occurs when the blood supply in the brain is disrupted, making it a major cause of death and disability (Campbell & Khatri, 2020). Worldwide, approximately 101.5 million people experienced a stroke in 2019, of whom 78.2 million had an ischaemic stroke, 20.7 million had an intracerebral haemorrhage, and 8.4 million had a subarachnoid haemorrhage Virani et al. 2021. The death rate due to stroke is high. In 2019, an estimated 3.3 million individuals died from ischaemic stroke, 2.9 million from intracerebral haemorrhage, and another half a million people from subarachnoid haemorrhage Virani et al. 2021. In addition, the mortality rate of stroke survivors is estimated to be 56% at 6 months, increasing to 61% at 12 months Lavados et al., 2021. Damage to the brain and subsequent cognitive, behavioural or physical disabilities commonly occur after stroke (Balasubramanian, 2015). Infarct volume in strategic brain regions such as the cortical limbic areas, heteromodal association areas including the frontal cortex, and white matter causes stroke victims to experience physical disability and have reduced cognitive function (Sun et al., 2014; Torrisi et al., 2019).

Interventions to support stroke survivors typically address physical function and disability include poor balance, impaired mobility, limited physical activity and activity daily living performance (Chen et al., 2021; Sarfo et al., 2018; Tchero et al., 2018).Primarily offered through in-person delivery for more than 15 years, many of these psychoeducational and behavioural interventions have been adapted for delivery by telephone or telehealth modalities (e.g. video, web), to increase accessibility and affordability (Banbury et al., 2018; Dawson et al., 2020). Furthermore, when the SARS-CoV-2 pandemic resulted in many in-person services and supports being paused, services such as neurological rehabilitation centres and long-term care facilities had to rapidly deploy telehealth solutions (Bernini et al., 2021; Mantovani et al., 2020; Seifert et al., 2020).

Telehealth is defined as the delivery and facilitation of health-related services including medical care, rehabilitation, health-related patient education and self-management via telecommunication technologies (Dinesen et al., 2016; Tuckson et al., 2017). Rehabilitation services use telecommunication technologies to assist stroke survivors in overcoming physical and cognitive impairments (Blek et al., 2018). The trend of rehabilitation for stroke patients is to use telehealth to augment conventional therapy with the aim of reducing disability and improving function (Sanchetee et al., 2021). There are many devices that can be helpful in maintaining the stroke survivor's interest and motivation such as virtual technologies, assistive devices, neuroprostheses and smartphone applications (Clark et al., 2019; Sanchetee, 2021). Using such devices during rehabilitation can facilitate their participation, thereby enhancing their overall well-being (Sanchetee, 2021).

What does this paper contribute to the wider global clinical community?

1. Telehealth interventions have been used as part of a rehabilitation approach for stroke survivors, and this meta-analysis proved that these interventions have clinical benefits.
2. Telehealth interventions positively affect stroke survivors' performance of ADLs.
3. Health care delivered via telehealth could meaningfully support stroke survivors.

There is some evidence supporting the use of telehealth for stroke survivors. For example, studies have shown that telehealth can provide rehabilitation services that effectively maintain and improve motor function and the performance of activities of daily living (ADLs) (Galloway et al., 2019; Knepley et al., 2021; Sarfo et al., 2018). A previous systematic review and meta-analysis including 1,339 participants showed that telehealth interventions did not enhance the performance of ADLs ($p = .47$) or motor function ($p = .10$) in stroke survivors (Tchero et al., 2018). However, an 8 week randomised controlled trial (RCT) conducted in Spain with 41 participants suggested that telehealth intervention significantly improved the performance of ADLs ($p = .009$) (Grau-Pellicer et al., 2020). In a 24 week RCT conducted in China with 54 participants, telehealth interventions were effective for improving balance ($p < .001$) and the stroke survivor's ability to perform ADLs ($p < .001$) (Chen et al., 2017a). Current study from Chen et al. (2021) reported that interactive telerehabilitation using kinect-camera improve balance in stroke survivor significantly ($p < .01$) (Chen et al., 2021).

These two recent studies have added to the knowledge base regarding the potential use of telehealth for stroke survivors. Continued efforts are needed to collect and analyse data on the effects of telehealth interventions on stroke survivors. Therefore, this meta-analysis focused on experimental studies such as RCTs, as they may provide robust evidence for the further development of telehealth interventions in rehabilitation programme.

2 | MATERIAL AND METHODS

This study was conducted to identify the effects of telehealth interventions on balance and the ability of stroke survivors to perform ADLs in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Page et al., 2021) (File S1 Supplementary documents 1, 2 and 3). This study has been registered with the International Prospective Register of Systematic Review: CRD42021254522.

2.1 | Search strategy

A systematic literature search was performed using Academic Search Complete, Cumulative Index to Nursing and Allied Health Literature, EMBASE, MEDLINE, PubMed, OVID (UpToDate) and the Web of Science databases for literature dated up to April 25, 2021. Further, grey literature through google scholar was performed. Medical Subject Headings terms used in our search included; 'stroke patients' OR 'post-stroke' OR 'stroke survivors' OR 'after stroke' AND 'digital health' OR 'digital medicine' OR 'mobile digital' OR 'electronic health' OR 'eHealth' OR 'mHealth' OR 'telehealth' OR 'telemedicine' OR 'telerehabilitation' OR 'tele-stroke' OR 'video conferencing' AND 'randomised controlled trial' OR 'randomised controlled study' OR 'randomly assigned' OR 'randomised'; the full list can be found in File S1 Supplementary document 1. The search was developed for one database and was later modified for other databases.

2.2 | Eligibility criteria

To determine the inclusion criteria, the Population, Intervention/Issue of Interest, Comparison, Outcome and Study (PICOS) method was used (Amir-Behghadami & Janati, 2020). Inclusion criteria were: (a) studies with stroke survivors; (b) studies that implemented telehealth intervention (i.e. videoconference, text messages and telephone calls); (c) RCTs, and studies published in English. Exclusion criteria were: (a) studies not within the scope of the PICOS criteria; (b) studies for which the full text was not available; and (c) study protocols. Two authors (IDS and DET) screened all relevant titles and abstracts against the eligibility criteria. Discrepancies were resolved through mutual consensus by the supervision of the third author (SOB).

2.3 | Study selection and data extraction

A literature search was performed across the seven databases. Duplicates were removed before the retrieved studies were screened. Two authors (IDS and DET) independently screened the studies by looking at the title and abstract. Next, the full text of the studies was screened. Any discrepancies in the screening process were resolved through a consensus discussion with a third reviewer. After the final studies were identified, two reviewers independently extracted key data points including the author, publication year, country, study design, intervention setting, participants' demographic data (e.g. total participants, number of women and age), intervention details (e.g. intervention type between groups, intervention provider, frequency and period of intervention and follow-up) and outcomes.

2.4 | Risk of bias assessment

Two authors (IDS and DET) independently evaluated each study using the revised Cochrane risk of bias tool for randomised trials (RoB-2) (Sterne et al., 2019). The seven domains of the RoB-2 include risk of bias arising from the randomisation process, risk of bias arising from the time of participant recruitment, risk of bias due to deviations from the intended interventions, risk of bias due to missing outcome data, risk of bias in measurement of the outcome, risk of bias in selection of the reported result, and overall risk of bias. A study was considered to have high overall bias if three of the seven domains were considered high risk. Finally, publication bias was determined by using funnel plots of the study effect size relative to the standard error as a visual aid for assessing systematic heterogeneity or bias. Any disagreement was resolved by a consensus-based discussion with a third author (SOB).

2.5 | Statistical analyses

2.5.1 | Data synthesis

The standardised mean difference (SMD) with 95% confidence interval (CI) was calculated when the included studies used different scales to measure the same outcome (Liu et al., 2017; Sedgwick & Marston, 2013). The treatment effect on the outcomes was measured from the change in mean and standard deviation (SD) between pre-and post-intervention using the combined results of different scales from each group. Therefore, the mean difference and SD were calculated, and then, the SMD effect size (Cohen's d) in the exercise group and control group was determined.

2.5.2 | Data analysis

Meta-analysis was used to analyse the potential heterogeneity of the variables, namely functional independence and balance. Heterogeneity was determined using the random-effects model for each variable through τ^2, Q and I^2; I^2 of 25%, 50% and 75% indicated low, moderate and high heterogeneity, respectively (Higgins et al., 2003). Publication bias was determined by the Egger's test and by displaying the visual funnel plot (Egger et al., 1997). Meta-analyses were conducted using STATA 16.0.

3 | RESULTS

3.1 | Study selection

A total of 675 studies were identified, of which 205 were duplicates and thus were not included in the analyses. The title and abstract of the remaining 470 studies were screened, of which 410 did not meet the PICOS method criteria for the following reasons: did not include the population of interest (*n* = 136), did not use telehealth interventions (*n* = 69), was not the study design of interest (*n* = 201) or was not published in English (*n* = 1). The full text of 60 studies was screened for eligibility, of which 46 were excluded because they did not include the population of interest (*n* = 16), did not use telehealth interventions (n = 6) or were not the study design of interest (n = 24). A total of 14 studies (Asano et al., 2019; Jing Chen et al., 2017; Chumbler et al., 2015; Chumbler et al., 2012; Grau-Pellicer et al., 2020; Huijbregts et al., 2009; Kotzian et al., 2019; Lin et al., 2014; Nilius et al., 2019; Redzuan et al., 2012; Sarfo et al., 2019; Schwab et al., 2007; Smith et al., 2012; Wang et al., 2020) were included in the final analysis. Seven studies were not included in the quantitative analysis because the mean and SD were not available. Figure 1 illustrates the PRISMA flow diagram showing the selection of studies.

3.2 | Study characteristics

All 14 studies included in this review were RCTs. Three studies were conducted in the United States, two were conducted in China and Germany, and one each was conducted in Austria, Canada, Ghana, Malaysia, Singapore, Spain and Taiwan. A total of 1,367 stroke survivors were included in the final analysis. The intervention settings were: the community (*n* = 5 studies), home (*n* = 2), hospital (*n* = 4), long-term care (*n* = 1), neurological rehabilitation centre (*n* = 1) and national stroke association (*n* = 1). The majority of participants were male (64%), although four studies did not report the gender of their participants. The ages of the participants ranged from 41 to 75 years.

The intervention providers were therapists (*n* = 5), nurses (*n* = 2), physicians (*n* = 5) and a researcher (*n* = 1); one study did not identify the intervention provider. Telehealth interventions for stroke survivors covered a range of educational topics, including physical exercise and the promotion of healthy behaviours. The total intervention time ranged from 1 to 12 months. The follow-up periods after the interventions were 3, 6 and 24 months. A summary of the study characteristics is presented in Table 1.

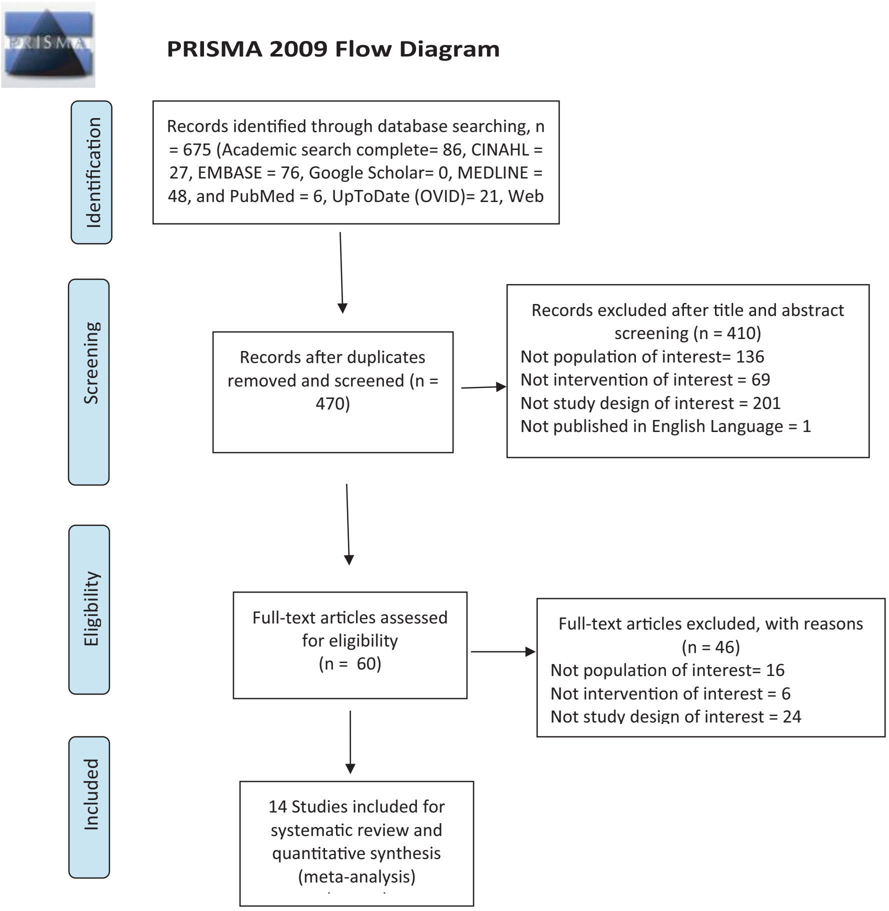


FIGURE 1 PRISMA Diagram – process of study selection [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Summary of included studie

				Participants			Intervention types
No	Author/year	Country	Setting	Sample size	Female	Mean of Age	Experimental group
1	Asano et al., 2019	Singapore	Community	124	59	64.1	Received telerehabilitation and a standardised rehabilitation programme. Telerehabilitation with sensors, hardware and recording exercises. The standardised programme comprised both physiotherapy & occupational therapy components
2	Chen et al., 2017	China	hospital	54	NA	≥66.15	Received physical exercise programmes with occupational therapy and also electrical stimulation parameters included stimulus duration of 5 s, intermittent time of 2 s, pulse width of 0.2 s, frequency of 50 Hz
3	Chumbler et al., 2015	USA	Home	48	NA	NA	Received home-based training in exercise and adaptive strategies.
4	Chumbler et al., 2012	USA	Home	48	1	≥67.1	Received 3 components of intervention: 1 h home visits to assess physical performance & help communicate the instruction of exercises & use of technology; daily use of an in-home messaging device; 5 telephone intervention calls
5	Grau-Pellicer et al., 2020	Spain	Community	41	20	≥62.96	Received 2 mhealth apps, Fitlab which monitors walking distance and walking speed and assesses mood, effort, recovery, wellness and fatigue.
6	Huijbregts et al., 2009	Canada	Community	18	NA	≥61.8	Received video conference, which includes both land and pool exercises.
7	Kotzian et al., 2019	Austria	Neurological Rehabilitation Centre Rosenhugel	251	79	≥56.8	Received a 30-min introductory lesson with nasal or oronasal mask fitting, device handling and information about positive airway pressure (PAP) therapy. Participants were provided an AirsenseTM 10 Autoset CPAP (Resmed) including a humidifier that was set to autotitrate at a pressure between 6 and 13 cm H_2O.
8	Lin et al., 2014	Taiwan	Long Term Care Facilities (LTCFs)	24	7	≥74.6	Received 3 sessions of training per week. Telebalance training focused on 10 min of standing exercise according to 3D animation exercise videos, which were Maya/3D Max Systems and ~10 min of 3D interactive games with finger touching of the touch screen in standing posture.
9	Nilius et al., 2019	Germany	Community	75	20	≥55.4	Received telemonitoring, telephone calls and remote interventions. The online data (adherence, leakage, pressure, apnoea-hypopnea index) were anonymously transferred to a password-protected web server each morning.

	Intervention provider	Frequency and period of intervention	Follow-up	Outcome
Control group				
Usual rehabilitation care	Therapist	1–3 sessions each session was an hour before discharge and continued at home for 3 months.	Baseline and 3 months	Physical function and quality of life
Treatment as usual	Therapists	1 h, twice per working day for 12 weeks	baseline, 12 and 24 weeks	Physical function and balance
Usual care	Clinicians	3 months	Baseline, 3 and 6 months	Physical function
Usual care	Teletherapist	3 times 3 visits: weeks 1, 3, 5; 5 telephone visits: weeks 2, 4, 6, 8, 12. 3–4 exercises. Period of intervention was 3 months	Baseline, 3 and 6 months	Self-efficacy and satisfaction
Usual care	NA	8-week in 2 days a week for 1 h sessions (16 sessions in total)	Baseline and 3 months	Physical function and quality of life
NA	NA	85-min exercises for 6 weeks	Baseline, 8 and 10 weeks	Balance and depression
NA	Trained nurse	Use the PAP for at least 4 h of sleep/night for 1 year	Baseline, 3 and 12 months	Cognitive function, physical function and quality of life
Conventional training programmes as usual	Therapists	10 min standing seeing animation, 10 min interactive games, 3 sessions per week for 4 weeks	Baseline and 4 weeks	Balance and physical function
Standard care	Clinicians	Use PAP devices <4 h/night over a week for 6 months	Baseline and 6 months	Sleep

(Continues)

TABLE 1 (Continued)

No	Author/year	Country	Setting	Participants: Sample size	Participants: Female	Participants: Mean of Age	Intervention types: Experimental group
10	Redzuan et al., 2012	Malaysia	Neurology ward	90	38	≥59.4	Received a self-instructional audiovisual DVD of standardised rehabilitation procedure consisting of 6 sessions. Participants received bimonthly outpatient therapy
11	Sarfo et al., 2019	Ghana	Outpatient neurology clinic	60	21	≥54.3	Received a bluetoothed UA−767Plus BT Blood Pressure (BP) device & smartphone with embedded application for monitoring & reporting BP measurements and medication intake under a nurse's guidance
12	Schwab et al., 2007	Germany	Community hospital	302	117	≥69.4	Received video conference including computed tomography (CT) scan and examination. A telemedical follow-up patient examination including NIHSS score and CT evaluation was performed 24 to 36 h after thrombolysis or earlier in the case of clinical deterioration
13	Smith et al., 2012	USA	National Stroke Association, Family Caregiver Alliance	32	NA	≥54.9	Received 5 component interventions: professional Guide, Educational Videos, Online Chat Sessions, Email and Message Board, and Resource Room. Evaluated weekly (and corresponding video)
14	Wang et al., 2020	China	Stroke patients after discharge from hospital	200	79	≥41.32	Received bluetooth sphygmomanometer and wearable bracelet, which connected to the 'regional health monitoring networks platform based on the mobile end devices'. The bluetooth sphygmomanometer monitored BP, BP fluctuation and blood glucose. Bracelet monitored quality of sleep, step count, mileage analysis, calorie consumption analysis and exercise target tracking.

Note: NA; Not Available

3.3 | Risk of bias in the studies

Overall, all of the included studies had a low risk of bias (Supplementary document 2). From the seven domains of the RoB-2, the potentially high risk of bias arising from the randomisation process was due to a lack of concealment of treatment and lack of participant blinding to the intervention, the therapist who administered the intervention, and the assessor. A high level of quality among the included studies in a meta-analysis is preferable. For the present meta-analysis, variance in the quality of the included studies was found. However, the examination of the funnel plots showed considerable symmetry for all of our outcome analyses, both of the outcomes; independency to perform activities of daily living and balance did not show an asymmetrical outlier on the funnel plot (Figures 2,3,4 and 5).

3.4 | Effects of telehealth on stroke survivors

3.4.1 | Independence in ADLs

A total of 190 participants across six studies were assessed using the Modified Barthel Index (Jing Chen et al., 2017), the Barthel Index (Grau-Pellicer et al., 2020; Kotzian et al., 2019; Lin et al., 2014) or the Late-Life Function and Disability Instrument (Chumbler et al., 2012) to measure cognitive function. The pooled SMD with random-effects model was .45 (95% CI: .12 to .78), and significant differences in ADL independence level were observed in the intervention group or in those who applied telehealth intervention (p = .01). The forest plot showed low heterogeneity among the studies (estimated $\tau^2 = .03$, Q = 5.10, df = 4, $I^2 = 21.51\%$) (Figures 2 and 4).

Control group	Intervention provider	Frequency and period of intervention	Follow-up	Outcome
Treatment as usual	Physiotherapists, occupational therapists, rehabilitation physicians	45 min self-instructional video, done at home daily for 2 weeks	Baseline and 3 months	Physical function
Standard care	physician, nurse	Twice a day, morning and evening BP monitoring for 3 months	Baseline and 3 months	Physical function
NA	Physician	15 min videoconference (CT scan transmission & examination), 24 to 36 h follow NIHSS and CT scan for 6 months	Baseline, 3 months and 6 weeks	Physical function
Access the Resource Room only	Clinical Psychologists, PhD student in Nursing	Video duration 17 min, online chat session weekly, for 1 month	Baseline, post- test and 1 month	Depression
NA	NA	Daily health education. If data of patients were normal for 2 weeks, health education was reduced to 3 times/week, for 1 year	Baseline, 3, 6, 9 and 12 months	Self-care ability

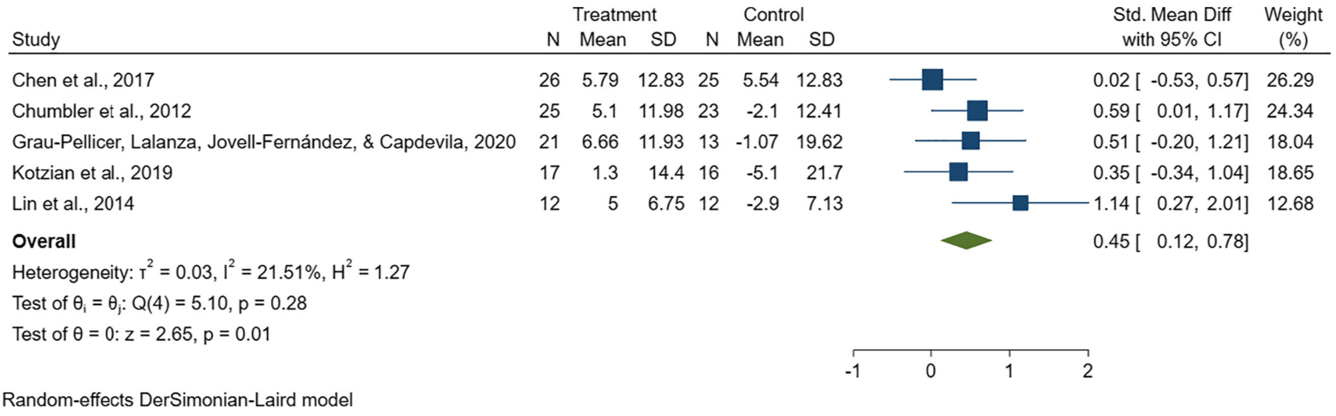
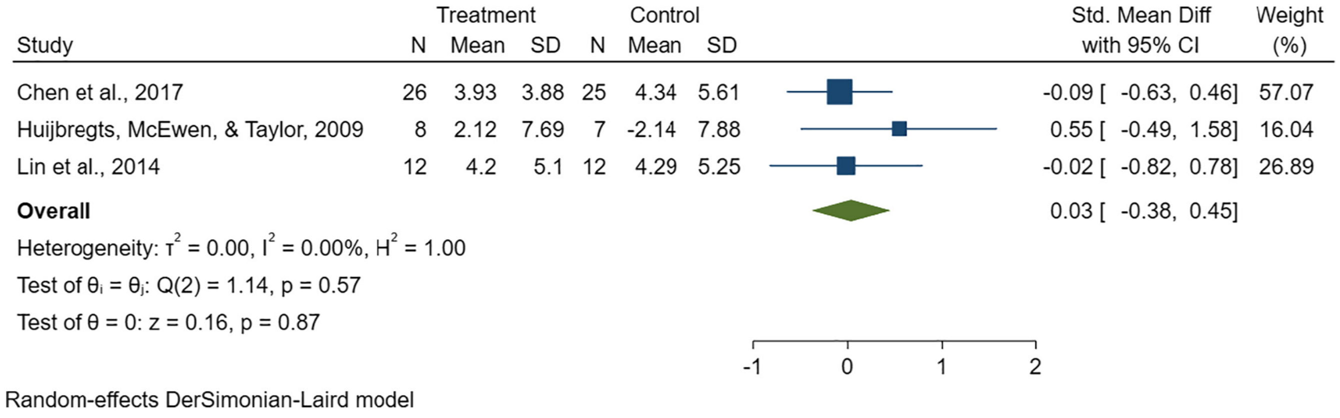


FIGURE 2 Forest plots of independency to perform activities of daily living [Colour figure can be viewed at wileyonlinelibrary.com]



Study	Treatment N	Treatment Mean	Treatment SD	Control N	Control Mean	Control SD	Std. Mean Diff with 95% CI	Weight (%)
Chen et al., 2017	26	3.93	3.88	25	4.34	5.61	-0.09 [-0.63, 0.46]	57.07
Huijbregts, McEwen, & Taylor, 2009	8	2.12	7.69	7	-2.14	7.88	0.55 [-0.49, 1.58]	16.04
Lin et al., 2014	12	4.2	5.1	12	4.29	5.25	-0.02 [-0.82, 0.78]	26.89
Overall							0.03 [-0.38, 0.45]	

Heterogeneity: $\tau^2 = 0.00$, $I^2 = 0.00\%$, $H^2 = 1.00$

Test of $\theta_i = \theta_j$: $Q(2) = 1.14$, $p = 0.57$

Test of $\theta = 0$: $z = 0.16$, $p = 0.87$

Random-effects DerSimonian-Laird model

FIGURE 3 Forest plots of balance [Colour figure can be viewed at wileyonlinelibrary.com]

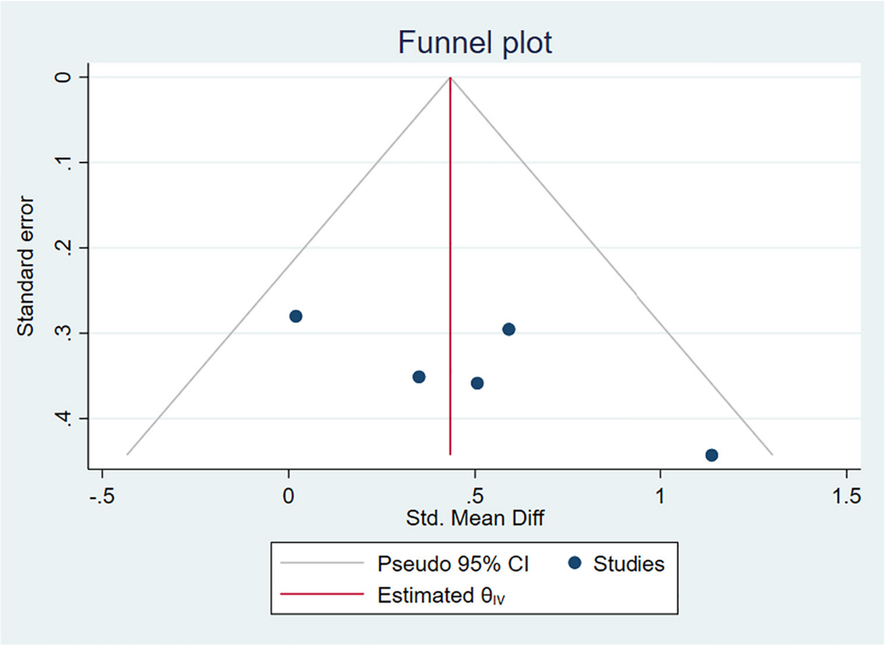


FIGURE 4 Funnel plots of independency to perform activities of daily living [Colour figure can be viewed at wileyonlinelibrary.com]

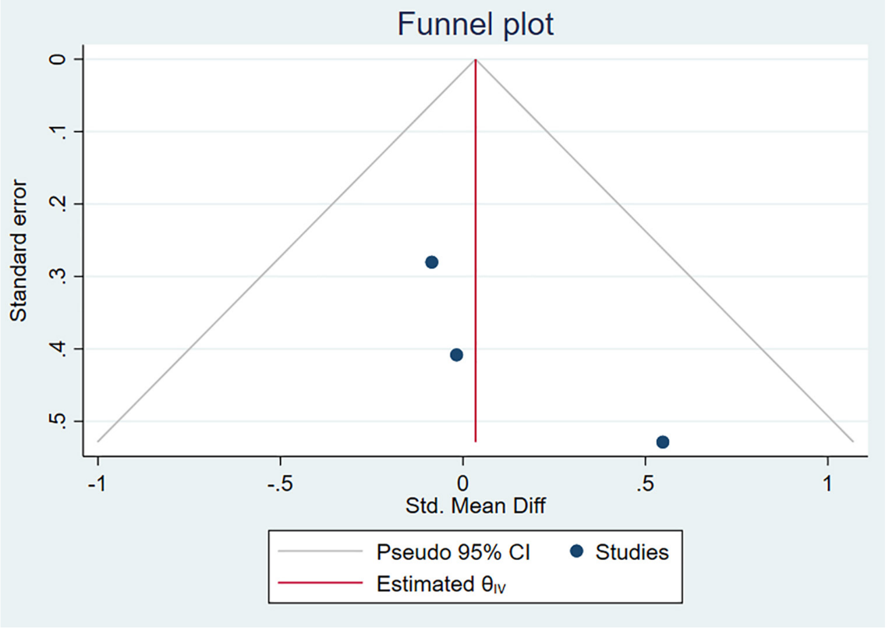


FIGURE 5 Funnel plots of balance [Colour figure can be viewed at wileyonlinelibrary.com]

3.4.2 | Balance

Three studies with 90 participants were assessed by the Berg Balance Scale (Jing Chen et al., 2017; Huijbregts et al., 2009; Lin et al., 2014), to measure their balance while performing ADLs. The pooled SMD with random-effects model was .03 (95% CI: −.38 to .45), and no significant differences in balance were found between the intervention and control groups ($p = .87$). The forest plot showed no heterogeneity among the studies (estimated $\tau^2 = .00$, $Q = 1.14$, $df = 2$, $I^2 = .00\%$) (Figures 3 and 5).

4 | DISCUSSION

The purpose of this meta-analysis was to examine the effectiveness of telehealth interventions in stroke survivors. Compared to routine or usual care (typical control condition), telehealth interventions yielded significant benefits in improving the performance of ADLs among stroke survivors; however, the intervention did not significantly improve balance. Recent systematic reviews have reported the positive contribution of telehealth in those who experience stroke, particularly for improving the stroke survivor's performance of ADLs and their balance (Chen et al., 2019; Dominguez-Tellez et al., 2019; Rooij et al., 2016).

The findings of this systematic review are consistent with previous systematic reviews showing that stroke survivors' abilities to perform ADLs were significantly improved through the use of different types of technology including games, telerehabilitation, virtual reality, sensors and tablets (Chen et al., 2019; Laver et al., 2011; Zhang et al., 2021). In addition to the utilisation of technologies, one important factor driving stroke survivors to achieve optimal independence is their focus on regaining their abilities to perform their ADLs (Cherry et al., 2017). Other studies have shown that approximately 25% to 74% of stroke survivors are dependent on others for their ADLs, and on average, a stroke survivor may experience at least .86, 1.24 or 1.39 years with mild, moderate or severe disabilities, respectively (Miller et al., 2010; Pei et al., 2016). Considering the high number of people affected by stroke, many interventions focus on improving ADLs because this is a crucial factor for improving quality of life (Kim et al., 2014; Pei et al., 2016). Early and intensive stroke rehabilitation is a strategy that can enhance stroke survivors' abilities to perform their ADLs, and this can be offered in a range of settings such as the hospital, community and during home-based rehabilitation (Hebert et al., 2016; Yagi et al., 2017).

Telehealth has expanded to home-based telerehabilitation aimed at helping patients have rehabilitation at home, which is particularly useful for patients who need long-term rehabilitation, such as stroke patients with balance disorders (Y. Chen et al., 2019; Schwamm, 2019). Our review showed that telehealth did not have significant effects on balance in stroke survivors, in accordance with previous studies (Appleby et al., 2019; Chen et al., 2017b, 2015). Those studies revealed that telehealth such as telerehabilitation and supervision alone are not superior to conventional strategies for balance rehabilitation, which involve physical interaction/companion of a therapist. The presence of a therapist has been identified as an important factor in improving balance (Schröder et al., 2019).

Virtual reality training is gaining popularity due to its effectiveness, efficiency and feasibility compared to traditional or conventional rehabilitation; some studies suggest that balance telerehabilitation, combined with virtual reality training, is more effective than balance training without virtual reality training (Lei et al., 2019; de Rooij et al., 2016; Zhang, Wang, et al., 2021). Virtual reality can play an important role in improving motor function by reshaping the contralateral sensor motor cortex, leading to reacquisition of locomotor skills and improving the ability of the brain to perceive, process and integrate information, thereby allowing stroke survivors to better maintain balance and control their posture (Lei et al., 2019; Lloréns et al., 2015). Studies have shown that home-based virtual reality training is more effective than conventional physical therapy (Feng et al., 2019; Lee et al., 2016; Karamians et al., 2020). Moreover, home-based virtual reality training gives stroke survivors the ability to continue ongoing rehabilitation at home in a more individualised, convenient and accessible setting (Lei et al., 2019; Sheehy et al., 2019). Virtual reality also provides patients a safe and controlled virtual environment (Chen et al., 2019); therefore, it is considered a promising novel therapy for stroke survivors, particularly those who have problems with balance recovery (de Rooij et al., 2016).

This systematic review also found that most articles on telehealth for stroke rehabilitation focus more on physical rehabilitation. However, depression is common after stroke, with an incidence of more than 50% and can lead to a lack of motivation to participate in rehabilitation (Song & Park, 2015). Therefore, it is necessary to develop more treatment options that focus not only on physical impairment but also on mental and psychosocial issues after stroke.

4.1 | Limitations

This review had several limitations. First, despite employing a comprehensive search strategy, a limited number of studies on balance among stroke survivors met the inclusion criteria. Second, methodological characteristics that might bias the results, for example, blinding of the outcome assessor, intention-to-treat analysis or allocation concealment, were not consistently reported in the identified studies. Third, this review only included studies published in English due to a lack of translator resources, which might have resulted in the omission of significant data from original papers published in other languages. Fourth, the statistical power of this meta-analysis may be limited by the inclusion of only 14 studies. Fifth, various levels risk of bias was presented in the included RCTs, indicating that more rigorous RCTs are necessary for the future. Finally, few available studies were identified, despite the performance of a comprehensive literature search that included eight databases. Some relevant studies may have been identified in other databases, such as PsychINFO and Scopus, which were not included in this study.

4.2 | Conclusion and Relevance to Clinical Practice

This review study concludes that telehealth interventions are beneficial and have positive effects on improving stroke survivors' performance of their ADLs. These findings confirm that the use of telehealth can be effective in delivering stroke-related education programmes to improve and prevent disability among stroke survivors. Future telehealth intervention trials should focus on identifying essential intervention delivery components and strategies that facilitate intervention adoption by clinicians and stroke survivors and sustain the positive effects on stroke survivors' performance of their ADLs in different settings (e.g. long-term care facilities, individual homes). In other words, study designs should include stroke survivor-centric assessments of process and outcomes (e.g. progress, challenges and barriers when performing ADLs) that could be administered and monitored by clinicians, patients or their family caregivers as appropriate. As for practical implications, implementation of telehealth-based interventions to improve stroke survivors' performance of their ADLs in real-world clinical or community settings is promising and needed. It is essential to build flexibility in the telehealth-based intervention delivery protocol to meet individual stroke survivors' needs to motivate and enhance their ADL performance.

AUTHOR CONTRIBUTION

Study conception and design: IDS, DET, Data collection: IDS, SOB, Data analysis and interpretation: IDS, Drafting of the article: IDS, SOB, DET, Critical revision of the article: All authors.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

ORCID

Ita Daryanti Saragih https://orcid.org/0000-0002-7177-5933

REFERENCES

Amir-Behghadami, M., & Janati, A. (2020). Population, Intervention, Comparison, Outcomes and Study (PICOS) design as a framework to formulate eligibility criteria in systematic reviews. *Emergency Medicine Journal*, *37*(6), 387. https://doi.org/10.1136/emermed-2020-209567

Appleby, E., Gill, S. T., Hayes, L. K., Walker, T. L., Walsh, M., & Kumar, S. (2019). Effectiveness of telerehabilitation in the management of adults with stroke: A systematic review. *PLoS One*, *14*(11), e0225150. https://doi.org/10.1371/journal.pone.0225150

Asano, M., Tai, B. C., Yeo, F. Y. T., Yen, S. C., Tay, A., Ng, Y. S., & Koh, G. C. (2019). Home-based tele-rehabilitation presents comparable positive impact on self-reported functional outcomes as usual care: The Singapore Tele-technology Aided Rehabilitation in Stroke randomised trial. *Journal of Telemedicine and Telecare*, https://doi.org/10.1177/1357633x19868905

Balasubramanian, S. (2015). Motor impairments following stroke.

Banbury, A., Nancarrow, S., Dart, J., Gray, L., & Parkinson, L. (2018). Telehealth Interventions Delivering Home-based Support Group Videoconferencing: Systematic Review. *Journal of Medical Internet Research*, *20*(2), e25. https://doi.org/10.2196/jmir.8090

Bernini, S., Stasolla, F., Panzarasa, S., Quaglini, S., Sinforiani, E., Sandrini, G., Vecchi, T., Tassorelli, C., & Bottiroli, S. (2021). Cognitive Telerehabilitation for Older Adults With Neurodegenerative Diseases in the COVID-19 Era: A Perspective Study. *Frontiers in Neurology*, *11*(1795), https://doi.org/10.3389/fneur.2020.623933

Blek, N., Szarpak, Ł., & Drejza, M. (2018). The use of digital technologies in stroke management in the world: an analysis of examples. *Postępy Nauk Medycznych*, *31*, 361–365. https://doi.org/10.25121/PNM.2018.31.6.361

Campbell, B. C. V., & Khatri, P. (2020). Stroke. *The Lancet*, *396*(10244), 129–142. https://doi.org/10.1016/S0140-6736(20)31179-X

Chen, J., Jin, W., Dong, W. S., Jin, Y., Qiao, F. L., Zhou, Y. F., & Ren, C. C. (2017). Effects of Home-based Telesupervising Rehabilitation on Physical Function for Stroke Survivors with Hemiplegia: A Randomized Controlled Trial. *American Journal of Physical Medicine & Rehabilitation*, *96*(3). https://doi.org/10.1097/PHM.0000000000000559

Chen, J., Jin, W., Dong, W. S., Jin, Y., Qiao, F. L., Zhou, Y. F., & Ren, C. C. (2017a). Effects of Home-based Telesupervising Rehabilitation on Physical Function for Stroke Survivors with Hemiplegia A Randomized Controlled Trial. *American Journal of Physical Medicine & Rehabilitation*, *96*(3), 152–160. https://doi.org/10.1097/phm.0000000000000559

Chen, J., Jin, W., Dong, W. S., Jin, Y., Qiao, F. L., Zhou, Y. F., & Ren, C. C. (2017b). Effects of Home-based Telesupervising Rehabilitation on Physical Function for Stroke Survivors with Hemiplegia: A Randomized Controlled Trial. *American Journal of Physical Medicine & Rehabilitation*, *96*(3), 152–160. https://doi.org/10.1097/phm.0000000000000559

Chen, J., Jin, W., Zhang, X.-X., Xu, W., Liu, X.-N., & Ren, C.-C. (2015). Telerehabilitation Approaches for Stroke Patients: Systematic Review and Meta-analysis of Randomized Controlled Trials. *Journal of Stroke and Cerebrovascular Diseases*, *24*(12), 2660–2668. https://doi.org/10.1016/j.jstrokecerebrovasdis.2015.09.014

Chen, S.-C., Lin, C.-H., Su, S.-W., Chang, Y.-T., & Lai, C.-H. (2021). Feasibility and effect of interactive telerehabilitation on balance in individuals with chronic stroke: a pilot study. *Journal of NeuroEngineering and Rehabilitation*, *18*(1), 71. https://doi.org/10.1186/s12984-021-00866-8

Chen, Y., Abel, K. T., Janecek, J. T., Chen, Y., Zheng, K., & Cramer, S. C. (2019). Home-based technologies for stroke rehabilitation: A systematic review. *Int J Med Inform*, *123*, 11–22. https://doi.org/10.1016/j.ijmedinf.2018.12.001

Cherry, C. O., Chumbler, N. R., Richards, K., Huff, A., Wu, D., Tilghman, L. M., & Butler, A. (2017). Expanding stroke telerehabilitation services to rural veterans: a qualitative study on patient experiences using the robotic stroke therapy delivery and monitoring system program. *Disabil Rehabil Assist Technol*, *12*(1), 21–27. https://doi.org/10.3109/17483107.2015.1061613

Chumbler, N. R., Li, X., Quigley, P., Morey, M. C., Rose, D., Griffiths, P., Sanford, J., & Hoenig, H. (2015). A randomized controlled trial on Stroke telerehabilitation: The effects on falls self-efficacy and satisfaction with care. *Journal of Telemedicine and Telecare*, *21*(3), 139–143. https://doi.org/10.1177/1357633x15571995

Chumbler, N. R., Quigley, P., Li, X., Morey, M., Rose, D., Sanford, J., Griffiths, P., & Hoenig, H. (2012). Effects of Telerehabilitation on Physical Function and Disability for Stroke Patients A Randomized. *Controlled Trial. Stroke*, *43*(8), 2168–2174. https://doi.org/10.1161/strokeaha.111.646943

Clark, W. E., Sivan, M., & O'Connor, R. J. (2019). Evaluating the use of robotic and virtual reality rehabilitation technologies to improve function in stroke survivors: A narrative review. *Journal* *of Rehabilitation and Assistive Technologies Engineering*, *6*, 2055668319863557. https://doi.org/10.1177/2055668319863557

Dawson, A., Walker, R., Campbell, J., Davidson, T., & Egede, L. (2020). Telehealth and indigenous populations around the world: a systematic review on current modalities for physical and mental health. *mHealth*, 30. https://doi.org/10.21037/mhealth.2019.12.03

de Rooij, I. J. M., van de Port, I. G. L., & Meijer, J.-W.-G. (2016). Effect of Virtual Reality Training on Balance and Gait Ability in Patients With Stroke: Systematic Review and Meta-Analysis. *Physical Therapy*, *96*(12), 1905–1918. https://doi.org/10.2522/ptj.20160054

Dinesen, B., Nonnecke, B., Lindeman, D., Toft, E., Kidholm, K., Jethwani, K., Young, H. M., Spindler, H., Oestergaard, C. U., Southard, J. A., Gutierrez, M., Anderson, N., Albert, N. M., Han, J. J., & Nesbitt, T. (2016). Personalized Telehealth in the Future: A Global Research Agenda. *Journal of Medical Internet Research*, *18*(3), e53. https://doi.org/10.2196/jmir.5257

Dominguez-Tellez, P., Moral-Munoz, J. A., Casado-Fernandez, E., Salazar, A., & Lucena-Anton, D. (2019). Effects of virtual reality on balance and gait in stroke: a systematic review and meta-analysis. *Rev Neurol*, *69*(6), 223–234. https://doi.org/10.33588/rn.6906.2019063

Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, *315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629

Feng, H., Li, C., Liu, J., Wang, L., Ma, J., Li, G., Gan, L. U., Shang, X., & Wu, Z. (2019). Virtual Reality Rehabilitation Versus Conventional Physical Therapy for Improving Balance and Gait in Parkinson's Disease Patients: A Randomized Controlled Trial. *Medical Science Monitor*, *25*, 4186–4192. https://doi.org/10.12659/msm.916455

Galloway, M., Marsden, D. L., Callister, R., Nilsson, M., Erickson, K. I., & English, C. (2019). The Feasibility of a Telehealth Exercise Program Aimed at Increasing Cardiorespiratory Fitness for People After Stroke. *International Journal of Telerehabilitation*, *11*(2), 9–28. https://doi.org/10.5195/ijt.2019.6290

Grau-Pellicer, M., Lalanza, J. F., Jovell-Fernández, E., & Capdevila, L. (2020). Impact of mHealth technology on adherence to healthy PA after stroke: a randomized study. *Topics in Stroke Rehabilitation*, *27*(5), 354–368. https://doi.org/10.1080/10749357.2019.1691816

Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). *Measuring Inconsistency in meta-analyses. BMJ (Clinical Research ed.)*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Huijbregts, M. P. J., McEwen, S., & Taylor, D. (2009). Exploring the Feasibility and Efficacy of a Telehealth Stroke Self-Management Programme: A Pilot Study. *Physiotherapy Canada*, *61*(4), 210–220. https://doi.org/10.3138/physio.61.4.210

Karamians, R., Proffitt, R., Kline, D., & Gauthier, L. V. (2020). Effectiveness of Virtual Reality- and Gaming-Based Interventions for Upper Extremity Rehabilitation Poststroke: A Meta-analysis. *Archives of Physical Medicine and Rehabilitation*, *101*(5), 885–896. https://doi.org/10.1016/j.apmr.2019.10.195

Kim, K., Kim, Y. M., & Kim, E. K. (2014). Correlation between the Activities of Daily Living of Stroke Patients in a Community Setting and Their Quality of Life. *Journal of Physical Therapy Science*, *26*(3), 417–419. https://doi.org/10.1589/jpts.26.417

Knepley, K. D., Mao, J. Z., Wieczorek, P., Okoye, F. O., Jain, A. P., & Harel, N. Y. (2021). Impact of Telerehabilitation for Stroke-Related Deficits. *Telemed J E Health*, *27*(3), 239–246. https://doi.org/10.1089/tmj.2020.0019

Kotzian, S. T., Saletu, M. T., Schwarzinger, A., Haider, S., Spatt, J., Kranz, G., & Saletu, B. (2019). Proactive telemedicine monitoring of sleep apnea treatment improves adherence in people with stroke- a randomized controlled trial (HOPES study). *Sleep Medicine*, *64*, 48–55. https://doi.org/10.1016/j.sleep.2019.06.004

Lavados P. M., Hoffmeister L., Moraga A. M., Vejar A., Vidal C., Gajardo C., Portales B., San Martín D., Lopez E., Rojo A., Olavarria V. V., Almeida J., Brunser A. M., Muñoz Venturelli P., Diaz V., Hoppe A., Sacks C. (2021). Incidence, risk factors, prognosis, and health-related quality of life after stroke in a low-resource community in Chile (ÑANDU): a prospective population-based study. *The Lancet Global Health*, *9*(3), e340–e351. http://dx.doi.org/10.1016/s2214-109x(20)30470-8

Laver, K. E., George, S., Thomas, S., Deutsch, J. E., & Crotty, M. (2011). Virtual reality for stroke rehabilitation. *Cochrane Database Syst*, *Rev(9)*, Cd008349. https://doi.org/10.1002/14651858.CD008349.pub2

Lee E. S., Vedanthan R., Jeemon P., Kamano J. H., Kudesia P., Rajan V., Engelgau M., Moran A. E. (2016). Quality Improvement for Cardiovascular Disease Care in Low- and Middle-Income Countries: A Systematic Review. *PLOS ONE*, *11*(6), e0157036. http://dx.doi.org/10.1371/journal.pone.0157036

Lei, C., Sunzi, K., Dai, F., Liu, X., Wang, Y., Zhang, B., He, L., & Ju, M. (2019). Effects of virtual reality rehabilitation training on gait and balance in patients with Parkinson's disease: A systematic review. *PLoS One*, *14*(11), e0224819. https://doi.org/10.1371/journal.pone.0224819

Lin, K. H., Chen, C. H., Chen, Y. Y., Huang, W. T., Lai, J. S., Yu, S. M., & Chang, Y. J. (2014). Bidirectional and Multi-User Telerehabilitation System: Clinical Effect on Balance, Functional Activity, and Satisfaction in Patients with Chronic Stroke Living in Long-Term Care Facilities. *Sensors*, *14*(7), 12451–12466. https://doi.org/10.3390/s140712451

Liu, C. J., Chang, W. P., Araujo de Carvalho, I., Savage, K. E. L., Radford, L. W., & Amuthavalli Thiyagarajan, J. (2017). Effects of physical exercise in older adults with reduced physical capacity: meta-analysis of resistance exercise and multimodal exercise. *International Journal of Rehabilitation Research*, *40*(4), 303–314. https://doi.org/10.1097/mrr.0000000000000249

Lloréns, R., Gil-Gómez, J. A., Alcañiz, M., Colomer, C., & Noé, E. (2015). Improvement in balance using a virtual reality-based stepping exercise: a randomized controlled trial involving individuals with chronic stroke. *Clin Rehabil*, *29*(3), 261–268. https://doi.org/10.1177/0269215514543333

Mantovani, E., Zucchella, C., Bottiroli, S., Federico, A., Giugno, R., Sandrini, G., Chiamulera, C., & Tamburin, S. (2020). Telemedicine and Virtual Reality for Cognitive Rehabilitation: A Roadmap for the COVID-19 Pandemic. *Frontiers in Neurology*, *11*, 926. https://doi.org/10.3389/fneur.2020.00926

Miller, E. L., Murray, L., Richards, L., Zorowitz, R. D., Bakas, T., Clark, P., & Billinger, S. A. (2010). Comprehensive overview of nursing and interdisciplinary rehabilitation care of the stroke patient: a scientific statement from the American Heart Association. *Stroke*, *41*(10), 2402–2448. https://doi.org/10.1161/STR.0b013e3181e7512b

Nilius, G., Schroeder, M., Domanski, U., Tietze, A., Schäfer, T., & Franke, K.-J. (2019). Telemedicine Improves Continuous Positive Airway Pressure Adherence in Stroke Patients with Obstructive Sleep Apnea in a Randomized Trial. *Respiration*, *98*(5), 410–420. https://doi.org/10.1159/000501656

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71.

Pei, L., Zang, X.-Y., Wang, Y., Chai, Q.-W., Wang, J.-Y., Sun, C.-Y., & Zhang, Q. (2016). Factors associated with activities of daily living among the disabled elders with stroke. *International Journal of Nursing Sciences*, *3*(1), 29–34. https://doi.org/10.1016/j.ijnss.2016.01.002

Redzuan, N. S., Engkasan, J. P., Mazlan, M., & Abdullah, S. J. F. (2012). Effectiveness of a Video-Based Therapy Program at Home After

Acute Stroke: A Randomized Controlled Trial. *Archives of Physical Medicine and Rehabilitation*, *93*(12), 2177–2183. https://doi.org/10.1016/j.apmr.2012.06.025

Sanchetee, P. (2021). *Current Trends in Stroke Rehabilitation*. IntechOpen.

Sarfo, F. S., Ulasavets, U., Opare-Sem, O. K., & Ovbiagele, B. (2018). Tele-Rehabilitation after Stroke: An Updated Systematic Review of the Literature. *Journal of Stroke and Cerebrovascular Diseases : the Official Journal of National Stroke Association*, *27*(9), 2306–2318. https://doi.org/10.1016/j.jstrokecerebrovasdis.2018.05.013

Sarfo, F S, Treiber, F, Gebregziabher, M, Adamu, S, Nichols, M, Singh, A, Obese, V, Sarfo-Kantanka, O, Sakyi, A, Adu-Darko, N, Tagge, R, Agyei-Frimpong, M, Kwarteng, N, Badu, E, Mensah, N, Ampofo, M, Jenkins, C, & Ovbiagele, B (2019). Phone-based intervention for blood pressure control among Ghanaian stroke survivors: A pilot randomized controlled trial. *International Journal of Stroke*, *14*(6), 630–638. https://doi.org/10.1177/1747493018816423

Schröder, J., van Criekinge, T., Embrechts, E., Celis, X., Van Schuppen, J., Truijen, S., & Saeys, W. (2019). Combining the benefits of tele-rehabilitation and virtual reality-based balance training: a systematic review on feasibility and effectiveness. *Disabil Rehabil Assist Technol*, *14*(1), 2–11. https://doi.org/10.1080/17483107.2018.1503738

Schwab, S., Vatankhah, B., Kukla, C., Hauchwitz, M., Bogdahn, U., Furst, A., Audebert, H. J., & Horn, M. (2007). Long-term outcome after thrombolysis in telemedical stroke care. *Neurology*, *69*(9), 898–903. https://doi.org/10.1212/01.wnl.0000269671.08423.14

Schwamm, L. H. (2019). Digital Health Strategies to Improve Care and Continuity Within Stroke Systems of Care in the United States. *Circulation*, *139*(2), 149–151. https://doi.org/10.1161/circulationaha.117.029234

Sedgwick, P., & Marston, L. (2013). Meta-analyses: standardised mean differences. *BMJ : British Medical Journal*, *347*, https://doi.org/10.1136/bmj.f7257. f7257.

Seifert, A., Batsis, J. A., & Smith, A. C. (2020). Telemedicine in Long-Term Care Facilities During and Beyond COVID-19: Challenges Caused by the Digital Divide. *Frontiers. Public Health*, *8*(690), https://doi.org/10.3389/fpubh.2020.601595

Sheehy, L., Taillon-Hobson, A., Sveistrup, H., Bilodeau, M., Yang, C., Welch, V., Hossain, A., & Finestone, H. (2019). Home-based virtual reality training after discharge from hospital-based stroke rehabilitation: a parallel randomized feasibility trial. *Trials*, *20*(1), 333. https://doi.org/10.1186/s13063-019-3438-9

Smith, G. C., Egbert, N., Dellman-Jenkins, M., Nanna, K., & Palmieri, P. A. (2012). Reducing Depression in Stroke Survivors and Their Informal Caregivers: A Randomized Clinical Trial of a Web-Based Intervention. *Rehabilitation Psychology*, *57*(3), 196–206. https://doi.org/10.1037/a0029587

Song, G. B., & Park, E. C. (2015). Effect of virtual reality games on stroke patients' balance, gait, depression, and interpersonal relationships. *Journal of Physical Therapy Science*, *27*(7), 2057–2060. https://doi.org/10.1589/jpts.27.2057

Sterne, J. A. C., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., Cates, C. J., Cheng, H.-Y., Corbett, M. S., Eldridge, S. M., Emberson, J. R., Hernán, M. A., Hopewell, S., Hróbjartsson, A., Junqueira, D. R., Jüni, P., Kirkham, J. J., Lasserson, T., Li, T., … Higgins, J. P. T. (2019). RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*, *366*, https://doi.org/10.1136/bmj.l4898. l4898.

Sun, J.-H., Tan, L., & Yu, J.-T. (2014). Post-stroke cognitive impairment: epidemiology, mechanisms and management. *Annals of Translational Medicine*, *2*(8), 8.

Tchero, H., Tabue-Teguo, M., Lannuzel, A., & Rusch, E. (2018). Telerehabilitation for stroke survivors: systematic review and meta-analysis. *Journal of Medical Internet Research*, *20*(10), e10867. https://doi.org/10.2196/10867

Torrisi, M., Maresca, G., De Cola, M. C., Cannavò, A., Sciarrone, F., Silvestri, G., Bramanti, A., De Luca, R., & Calabrò, R. S. (2019). Using telerehabilitation to improve cognitive function in post-stroke survivors: is this the time for the continuity of care? *International Journal of Rehabilitation Research*, *42*(4), 344–351. https://doi.org/10.1097/mrr.0000000000000369

Tuckson, R. V., Edmunds, M., & Hodgkins, M. L. (2017). Telehealth. *New England Journal of Medicine*, *377*(16), 1585–1592. https://doi.org/10.1056/NEJMsr1503323

Virani S. S., Alonso A., Aparicio H. J., Benjamin E. J., Bittencourt M. S., Callaway C. W., Carson A. P., Chamberlain A. M., Cheng S., Delling F. N., Elkind M. S.V., Evenson K. R., Ferguson J. F., Gupta D. K., Khan S. S., Kissela B. M., Knutson K. L., Lee C. D., Lewis T. T., … Tsao C. W. (2021). Heart Disease and Stroke Statistics—2021 Update. *Circulation*, *143*(8). http://dx.doi.org/10.1161/cir.0000000000000950

Wang, S., Li, Y., Tian, J., Peng, X., Yi, L., Du, C., Feng, C., Liu, C., Deng, R., & Liang, X. (2020). A randomized controlled trial of brain and heart health manager-led mHealth secondary stroke prevention. *Cardiovascular Diagnosis and Therapy*, *10*(5), 1192–1199. https://doi.org/10.21037/cdt-20-423

Zhang, B., Li, D., Liu, Y., Wang, J., & Xiao, Q. (2021). Virtual reality for limb motor function, balance, gait, cognition and daily function of stroke patients: A systematic review and meta-analysis. *Journal of Advanced Nursing*, https://doi.org/10.1111/jan.14800

Zhang, Z. Q., Wang, C. J., Xia, W. G., Li, J. W., Wang, Y. L., & Liu, Y. (2021). Efficacy and safety of mechanical thrombectomy for cardioembolic stroke A protocol for systematic review and meta-analysis. *Medicine*, *100*(2), https://doi.org/10.1097/md.0000000000024340

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Saragih, I. D., Tarihoran, D. E. T. A. U., Batubara, S. O., Tzeng, H.-M., & Lin, C.-J. (2022). Effects of telehealth interventions on performing activities of daily living and maintaining balance in stroke survivors: A systematic review and meta-analysis of randomised controlled studies. *Journal of Clinical Nursing*, 31, 2678–2690. https://doi.org/10.1111/jocn.16142