Title: Look Before You Leap: Interventions Supervised via Telehealth Involving Activities in Weight-Bearing or Standing Positions for People After Stroke—A Scoping Review

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ABSTRACT

Objectives: The COVID-19 pandemic has seen a rapid shift to telehealth delivered physical therapy services. Common impairments after stroke create unique challenges when providing rehabilitation via telehealth, particularly when it involves activities undertaken in weight-bearing or standing positions, including walking training. Our scoping review maps the evidence regarding safety, efficacy and feasibility of remotely supervised telehealth interventions involving activities undertaken in weight-bearing or standing positions for people after stroke.

Methods: Searches of relevant databases for primary research studies were conducted using keywords relating to exercise and telehealth. Studies of stroke survivors undertaking interventions involving activities in weightbearing or standing positions, supervised in real-time via telehealth were included. Two reviewers independently appraised all studies. Data were charted by one reviewer, checked by another and results synthesized narratively.

Results: Seven studies (two randomized trials, one mixed-methods and four pre-post studies) were included, involving 179 participants. Some studies included stroke survivors with cognitive impairment and two (29%) studies only included participants who walked independently. Adherence (reported in three studies) and satisfaction (reported in four studies) was good, and no serious adverse events (data from four studies) related to interventions were reported. Strategies to overcome technological barriers were used to optimize intervention safety and feasibility, along with physiological monitoring, caregiver assistance and in-person exercise prescription. However, there is limited high quality evidence of efficacy.

Conclusions: We identified strategies used in research to date which can support current practice. However, urgent research is needed to ensure that stroke survivors are receiving evidence-based, effective services.

Impact: The COVID-19 pandemic has necessitated a rapid shift to telerehabilitation services for people with stroke, but there is little evidence to guide best practice. Our review provides practical guidance and strategies to overcome barriers, and optimize safety and adherence for telehealth interventions involving activities in weightbearing or standing positions.

INTRODUCTION

Our world is currently amid the COVID-19 pandemic. Health systems are under pressure, and are implementing practices to minimize transmission and rationalize services in order to cope with the influx of COVID-19 patients.[1,2] For people with stroke, this has meant shorter inpatient rehabilitation admissions and the suspension of, or reduced capacity of outpatient and home-based services.[3] In response there has been a rapid shift to deliver rehabilitation services remotely via telehealth to optimize the safety of healthcare workers and their patients.[4,5]

Rehabilitation is an essential service that optimizes function and reduces disability.[3,6] However, people with stroke have been identified as a COVID19-vulnerable group and are being encouraged, if not mandated, to stay at home. Precautionary isolation has resulted in a lack of accessible rehabilitation. This has serious implications for stroke survivors' recovery,[7] and levels of physical activity which could increase their risk of further vascular events.[8] Telehealth delivered rehabilitation is now essential.[3]

Prior to the COVID-19 pandemic, telehealth was emerging as a potential alternative model of rehabilitation service delivery for people with stroke.[9-11] Two recent systematic reviews [9,10] included interventions aimed at improving a range of post-stroke sequelae including arm activity, functional mobility, communication, depressive symptoms, caregiver support and case management. These reviews were limited to randomized trials, and only a small number of included trials involved rehabilitation programs delivered in real time via telehealth including activities undertaken in weight-bearing or standing positions or involving walking training. Our review specifically focusses on these interventions because they are important for improving balance, walking ability, and cardiovascular fitness after stroke.[12,13] We have included a broad range of study designs in order to identify and synthesize information regarding the unique safety and feasibility challenges of these interventions.

Scoping reviews provide a mechanism for disseminating research findings to those who might otherwise lack the time or resources to undertake the work themselves and may identify gaps in research evidence.[14] The aim of this scoping review was to synthesise findings from studies of telehealth-delivered interventions involving activities undertaken in weight-bearing or standing positions (including walking or pre-walking training) for people after stroke to inform the rapid transition to this mode of therapy resulting from the COVID-19 pandemic. Our specific research questions were:

1. What are the key characteristics of the interventions delivered (including type, frequency, duration and intensity of exercise and telehealth modalities used)?
2. What are the characteristics of the stroke survivor participants (including stroke severity, ability to stand and walk, cognitive function and communication ability)?
3. What are the barriers and limitations to these interventions and what strategies were used to mitigate these?
4. What strategies were used to optimise safety, feasibility, delivery and adherence?
5. What is the effectiveness and cost-effectiveness of supervised telehealth interventions which involves activities undertaken in weight-

bearing or standing positions after stroke?

6. What are health professionals', participants', and caregivers' experiences of, or attitudes towards, supervised exercise delivered via telehealth?

METHOD

The results from this paper are derived from a broader systematic scoping review, investigating *supervised exercise delivered via telehealth in real time to manage chronic conditions in adults*. The scoping review protocol is published (Ramage, 2019)[15] and was conducted in accordance with the PRISMA extension for Scoping Reviews (PRISMA-ScR)[16] and followed the Arksey and O'Malley framework.[14] Following the onset of the COVID-19 pandemic, the authors made the decision to split the original scoping review[15] to rapidly publish this first paper focussing on telerehabilitation for stroke survivors to address urgent questions being asked by clinicians.

Data sources and searches

A comprehensive, systematic search of Medline, CINAHL, Scopus, Cochrane, Pedro and Embase databases was conducted in September 2018. Searches included use of the relevant index terms and keywords for 'exercise' and 'telehealth.' After the decision to split the scoping review had been made, an updated search identifying studies using the relevant index terms and keywords for 'exercise' and 'telehealth' and 'stroke' was conducted in May 2020. Feasibility limitations of the review meant only studies published in English were included. No restrictions were placed on initial date of publication. Full details of the Medline search strategies are shown in Supplementary Appendix 1.

Study selection

Titles and abstracts from all studies identified through the search strategy were independently reviewed by two authors, with conflicts resolved by a third. All authors were involved in screening of the title and abstracts. The full text of all potential titles was reviewed against the inclusion criteria by two authors (ER, NF, or AP). Any conflicts were resolved by consensus or a third author (CE). Consistent with the iterative nature of scoping reviews and in response to the large amount of records arising from the initial searches, we refined the original inclusion and exclusion criteria[15] to allow us to optimally address the research questions of the review (Tab. 1). This involved the additional exclusion of research protocols, case reports, studies involving transcranial direct current stimulation, studies aimed at improving arm activity, and conference abstracts or papers.

Reference lists of all included studies and relevant systematic reviews were searched. Experts in the field were contacted to identify any other pertinent research. Author contact was attempted where further information was needed to clarify if studies met the inclusion criteria or regarding outcomes related to our research questions.

Data extraction and quality assessment

A standardized data charting form was drafted by two authors (CE and ER), piloted by other authors and calibrated to ensure it would allow us to optimally answer our research questions. Data sought included characteristics of interventions, participants, barriers and limitations, feasibility, adherence, delivery, experience, attitudes, effectiveness, cost-effectiveness and safety, including adverse events related to the intervention. Data charted is synthesized in Tables 2–5. Data were charted for all studies by the lead author (ER) and checked by another author for accuracy with any discrepancies resolved by consultation. While not an essential step for scoping reviews, we undertook assessment of research quality in order to inform the recommendations of this review. Two authors critically appraised each randomized trial using *The Cochrane Collaboration's tool for assessing risk of bias*[17] and the mixed methods study using the *Mixed Methods Appraisal Tool (MMAT) – Version 2018.*[18]

Data synthesis and analysis

Quantitative and qualitative data are presented in tabular format and synthesized narratively, prioritising information relevant to our research questions.

RESULTS

Flow of studies through the review

We identified 28,522 titles and abstracts, reviewed 501 full text articles and included seven studies[19-25] in our review (n=179 participants). Flow of studies is summarized in the Figure 1. Studies were published between 2004 and 2019, with 5 (71%) published in the last 5 years. Sample sizes ranged from 15 to 54. Four included studies were single group pre-post designs,[19,21-23] two were randomized trials,[20,24] and one was a mixed methods study.[25]

Quality assessment

A risk of bias assessment was carried out on the two included randomized trials[20,24] (Suppl. Appendix 2). Overall, the risk of bias was low in both trials. Due to the nature of the telehealth interventions, blinding of participants and personnel was not possible. The pre-post studies[19,21-23,25] included in the review are inherently at high risk of bias.[26] Appraisal of the mixed-methods study[25] found overall it was well conducted, but included a risk of non-response bias.

Key characteristics of the telehealth interventions

Four of the seven studies included involved balance exercises as part of their intervention.[20,23-25] Other interventions included aerobic exercise,[21] strength training[23] and functional exercises including walking training.[19,20] Supervised exercise sessions lasted between 10-60 minutes per session, occurred between one and five days per week, and the intervention periods ranged from three weeks to three months. All studies utilized videoconferencing systems, and two utilized these in combination with gaming systems.[23-25] Interventions in five of the seven studies were delivered in participants' homes. The remaining 2 interventions were delivered in groups with participants present in-person at the same location, one took place in a long-term care facility[24] (maximum of 2 participants per group), the other in a community centre (6-8 participants per group).[23] One study provided opportunity for group delivered exercise sessions into participant's individual homes via videoconference, however participants were unable so see or hear each other during sessions.[19] Key study characteristics are summarized in Table 2.

Characteristics of included participants

The mean age of study participants ranged from 53[22] to 75[24] years. The inclusion criteria for one study required participants to be capable of sitting without support,[24] two required participants to be able to walk without assistance,[21,23] one modified the inclusion criteria during the study and required that participants be able to stand without support.[25] Three studies did not specify a minimum mobility requirement.[19,20,22] Mean or median scores on the Montreal Cognitive Assessment (MoCA) or Mini-Mental State Examinations (MMSE) reported in 4 studies were at[20,22,25] or just above[21] the cut-off for cognitive impairment screening in people with stroke (23 or 24 for the MoCA and 26 or 27 for the MMSE).[27] One study excluded stroke survivors with cognitive deficits and/or the absence of a caregiver who could provide informal care,[19] four studies applied inclusion or exclusion criteria which ensured a minimum level of cognition,[20,23-25] and four studies applied criteria related to the ability to follow instructions.[21,22,24,25] One study excluded stroke survivors with significant communication barriers,[23] two studies excluded people with impaired vision[24,25] and one excluded people with impaired hearing.[24] One study specifically included participants who were less than three months post stroke,[20] three studies required participants to be at least three months post stroke,[21,23,24] two studies included a mixture of subacute and chronic stroke participants,[19,25] and one study did not specify time post stroke in their inclusion criteria.[22]

Barriers and limitations

Technical barriers prevented the enrolment of 6% of stroke survivors expressing interest in the study of Galloway et al (2019),[21] and two otherwise eligible participants from the study by Palmcrantz et al (2017).[25] Thirty-three percent of participants enrolled in the study by Huzmeli et al (2016)[22] didn't complete the intervention due to technical difficulties (Tab. 3). Bernocchi et al (2016) found the lack of an available caregiver for the intervention period prevented the enrolment of 39% of stroke survivors screened for their study.[19] Galloway et al (2019) reported 14% of those expressing interest in the study were ineligible due to a lack of another suitable person to be present during exercise sessions[21] (Tab. 3). Two studies addressed barriers experienced during intervention delivery (Tab. 3).[21,25] Technology related barriers identified included internet issues; inadequate sound and visual quality during videoconferences; and issues with the technical equipment used including bespoke telehealth systems and heart rate monitors. Palmcrantz et al. (2017)[25] reported most participants needed help from caregivers to manage technology, and Galloway et al. (2019)[21] found 6 (29%) participants were unable to operate the telehealth system independently.

Adherence, attitudes, and experience of health professionals, participants, and caregivers

Measures of adherence varied. One study reported the mean number of sessions performed (87%)[25], another reported overall attendance (87%) [23] and a third reported the percentage of scheduled sessions that occurred via telehealth (85%).[21] Drop-outs were reported in all studies and ranged from 4%[24] to 33%.[22] Four studies reported participant satisfaction, which overall appeared to be good[19,21,23,24] (Tab. 3). Galloway et al (2019)[21] found a minority (29%) of participants would have preferred to go to a central venue rather than exercise at home if they had transport and 19% of participants reported disliking some technological aspects of the intervention, particularly the heart rate monitors. Two of the seven studies in the review involved group therapy; participants in these studies reported no preference for face-to-face over telehealth-delivered sessions[23] and no difference in satisfaction between telehealth and in-person interventions.[24] One study reported no significant difference in caregiver stress between the telehealth and centre-based interventions[20] and another reported the majority of caregivers reported reduced levels of burden and strain over the intervention period[19].

Strategies used to optimize safety, feasibility, and experience

Strategies for optimising safety and feasibility in the seven included studies (Tab. 4) included: in-person initial exercise prescription (five studies);[19-22,25] non-health professional in-person supervision or assistance (five studies)[19-22,24] or a non-professional person on site during the exercise session (one study);[23] physiological monitoring pre, post or during exercise sessions (four studies);[20,21,23,24] and, in-person education or demonstration of the telehealth system (three studies).[20,21,25] Five studies excluded people with one or more co-morbidities that would likely limit their ability to safely participate in exercise[20,21,23-25] (Tab. 4), with cardiac conditions the most common co-morbidity identified as a reason for exclusion. Details of all inclusion and exclusion criteria are reported in Supplementary Appendix 3. One study required participants to have medical clearance to exercise prior to participation.[21] Only three studies (n =93) specifically reported adverse events,[20,21,25] with only one adverse event related to an intervention reported (a fall requiring medical attention).[21] Bernocchi et al (2016)[19] did not formally report adverse events, however three participants did not complete the intervention due to hospitalisation (one fractured femur, one subarachnoid haemorrhage following a fall, and one due to respiratory problems), although none of these events were related to the study intervention. Strategies used to optimize participant adherence and experience (Suppl. Appendix 4) included provision of support by caregivers, therapist and technicians; ensuring participants had access to a suitable exercise environment; provision of individualized exercise; provision of an intervention that was convenient and accessible.

The effectiveness and cost-effectiveness of telehealth interventions

Key results of included studies are summarized in Table 5. There were no significant differences in the effect of interventions delivered via telehealth compared with face to face for activities of daily living and balance (2 randomized trials, n = 78)[20,24] and caregiver burden (1 randomized trial, n=54).[20] In the included pre-post studies, improvements were found in balance (3 studies, n=62),[19,22,23] and activities of daily living (one study),[19] but not exercise capacity (1 study, n = 21).[19] Self-reported quality of life were measured in two pre-post studies,[22,23] with significant improvements found in most items in one study,[23] but no change in the other.[22] No studies addressed cost effectiveness of interventions.

DISCUSSION

We identified a small number of published primary research studies (excluding case reports) involving activities undertaken in weight-bearing or standing positions, supervised via telehealth for people with stroke. This included two randomized trials[20,24] all with small sample sizes. The types of exercise delivered in the included studies included balance, aerobic, strength, walking training and functional exercises. Most studies specified a minimum mobility requirement for participation, ranging from the ability to sit without support[24] to being able to walk independently.[21,23] Participants generally reported good or high levels of satisfaction, although the measures used, and their focus (e.g. overall or telehealth modality satisfaction) varied between each study. Comparable results were found in trials evaluating telehealth and in-person delivered exercise, results from pre-post studies identified improvements in some participant outcome's such as balance and function, and there was an absence of reported serious adverse events. All bar one of the studies included people 3 months or more post-stroke. We were unable to determine the number of participants more than 6 months post stroke in our review because a lack of reporting on this characteristic. However, it is plausible that a substantial proportion of included participants were greater than 6 months post stroke and this may explain the minimal gains found for some outcomes, as recovery rates tend to slow after 6 months.[28] Overall, the use of telehealth to deliver supervised interventions involving activities undertaken in weight-bearing or standing positions appear promising for some people after stroke. However, there is limited evidence for effectiveness, due to the lack of adequately powered trials.

The overall paucity of evidence limits any firm conclusions regarding the efficacy and safety of supervised interventions involving activities undertaken in weight-bearing or standing positions delivered via telehealth after stroke. Broader systematic reviews regarding telerehabilitation after stroke suggest that it may not be inferior to usual care or in-person therapy, but consistent with our review, there is insufficient evidence to draw definitive conclusions.[9,10] However, in-person therapy is limited during the COVID-19 pandemic. This raises questions around the need for current research to address non-inferiority. We would advocate research should be focused on evaluating the safety and effect of telehealth delivered, supervised exercise programs. The few studies in our review that measured adverse events reported that these rarely occurred, but more research is needed to confirm the safety of telehealth delivered interventions involving activities undertaken in weight-bearing or standing positions after stroke. These findings are consistent with a recent review,[10] and highlight the urgent need for the evaluation of services that are shifting rapidly to telehealth delivered services.

Effective strategies to optimize the safety and feasibility of interventions involving activities undertaken in weight-bearing or standing positions delivered via telehealth are likely to vary with activity type, the environment, and participant's health and ability. Our review found caregiver assistance was a potential strategy to increase safety and overcome technological barriers, but also a barrier to participation for those without access to a caregiver. Therefore, strategies used should reflect the risks of individual stroke survivors, rather than employing a one-size fits all approach – for example making access to caregiver support a prerequisite of therapy. Technology related barriers were prominent in our review with three studies reporting they prevented the enrolment of some stroke survivors. However, satisfaction and adherence (when measured) of enrolled participants was good or high, suggesting barriers could be mitigated in most studies. An exception to this was the study by Huzmeli et al. (2017),[22] who did not measure adherence or satisfaction but reported 33% of enrolled participants did not complete the study due to technical issues. Strategies which may help moderate barriers to technology identified in our review included high speed internet, in-person training regarding the telehealth system, appropriate positioning of technology in participants' homes, telehealth support (from a health care professional or technician) via phone or in-person, and caregiver assistance. Barriers such as inadequate internet, and facilitators such as technician support, highlight that successful intervention delivery relies on infrastructure and resources beyond a clinician's control. It is vital that healthcare and government policy aligns to support the provision of telehealth delivered services to ensure the delivery of stroke care is not restricted by a lack of cohesion between policy and practice.

Falls and other adverse events are common after stroke.[29-32] Physical therapists routinely prescribe stroke survivors exercises or activities to be undertaken in weightbearing or standing positions without health professional supervision, thus it may be reasonable to assume the risks associated with remotely supervised exercise are similar. However, individualized home exercise is traditionally prescribed in-person for stroke survivors so therapists can undertake 'hands on' physical assessment and treatment. It remains unclear if this is necessary to ensure the safe prescription of some, or all, exercise types to stroke survivors, or specific subpopulations of stroke survivors. Most studies in our review provided in-person assessment and exercise prescription. While we did not specifically search for assessment via telehealth, none of the studies we reviewed reported assessment via telehealth. Current restrictions related to the COVID-19 pandemic limit in-person assessment and exercise prescription, thus research regarding assessment via telehealth is a priority for future research. Along with in-person exercise prescription, other strategies identified to optimize safety in our review included physiological monitoring and someone available to supervise or assist during sessions. A review by Piotrowicz et al (2016) regarding telerehabilitation for people with heart failure similarly identified strategies involving caregivers accompanying patients, patient monitoring, and individualized approaches to tailoring of exercise as factors influencing telerehabilitation safety.[33] In addition to this, Piotrowicz et al (2016) identified risk stratification and initial education sessions (self-evaluation) as factors influencing telerehabilitation safety.[33] Such strategies appear generalizable to the stroke population and may warrant further investigation.

Because studies identified in our review were published prior to the COVID-19 pandemic it is plausible that some reported telehealth barriers may no longer be current. In the study of Galloway et al (2019) for example, over a quarter of participants would have preferred in-person therapy if they had transport, and some stroke survivors declined participation due to an inability, unwillingness or concern about their ability to operate telehealth systems. During the COVID-19 pandemic, in-person therapy is restricted and carries new risks for stroke survivors. Furthermore, the use of telehealth has expanded rapidly and its benefits, particularly for vulnerable populations, are becoming better recognized. This may sway both health professional and consumer preferences for these types of interventions.

Strengths and Limitations

Our review used a comprehensive search strategy and detailed data extraction to map the evidence regarding supervised interventions involving activities undertaken in weight-bearing or standing positions, delivered via telehealth after stroke. Unlike previous systematic reviews in stroke telehealth, this scoping review focused on strategies used to optimize safety and feasibility to provide much needed practical information to researchers and clinicians responding to the challenges of COVID-19. However, we recognize reporting these outcomes was not the primary purpose of the included papers and therefore information regarding these outcomes is likely incomplete. We acknowledge that, in addition to supervised exercise delivered via telehealth, many of the interventions in our review included other aspects of support or therapy such as telesurveillance, social support, unsupervised home exercise and electromyography triggered neuromuscular stimulation, which may have confounded our findings. The majority of studies included exercise that was individualized to participants' abilities, and exercise programs consisted of a variety of exercises undertaken in a variety of starting positions (for example, sitting or standing). We could not determine what proportion of the program was undertaken in weightbearing or standing positions.

Walking retraining forms an important part of rehabilitation after stroke, yet only one study described including this as one (of many) components in their intervention,[20] while another described *walking* as an exercise prescribed to some participants.[19] Over half of the included studies' criteria for inclusion required a minimal level of cognition. This potentially limits the generalizability of our results. Therefore, in clinical practice the delivery of these types of interventions to people with cognitive deficits after stroke requires caution. Furthermore, clinicians should consider that the strategies used to optimise safety and feasibility identified in this study may not apply to interventions primarily aimed at walking retraining. Only one study included a follow-up period[20] and therefore the long-term impact of supervised telehealth exercise interventions after stroke is unknown.

Future Implications

During the COVID-19 pandemic there is rapid and necessary transition to supervised exercise delivered via telehealth for stroke survivors. Our review identifies that there is a lack of evidence to support or refute the safety and efficacy of interventions involving activities undertaken in weight-bearing or standing positions that are delivered via telehealth. In the absence of evidence, clinicians must rely strongly on clinical reasoning skills, however the strategies identified in this review may inform delivery of a safe, feasible model of telehealth care. There is an urgent need for researchers to work with clinicians to evaluate the efficacy and safety of these interventions. Outcomes that reflect patient performance are needed as part of this evaluation. The use of wearable technology may provide a solution to objective assessments, particularly where validated in-person assessment opportunities are limited. Furthermore, research should consider stroke survivors of all physical, cognitive and communication abilities, and the potential need for remote assessment and remote exercise prescription. Beyond the COVID-19 pandemic this research will provide important information to overcome barriers to rehabilitation after stroke which include distance and transport.[34,35]

Author Contributions

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Disclosures

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C. English and D.L. Marsden are coauthors of an included paper. They were not involved in the data extraction for that paper.

References

1. Fisk M, Livingstone A, Pit SW. Telehealth in the Context of COVID-19: Changing Perspectives in Australia, the United Kingdom, and the United States. *J Med Internet Res.* 2020;22:e19264.
2. Australian Government. Providing health care remotely during COVID-19. Department of Health. https://www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/coronavirus-covid-19-advice-for-the-health-and-aged-care-sector/providing-health-care-remotely-during-covid-19. Published 2020. Accessed 05/10/2020, 2020.
3. Prvu Bettger J, Thoumi A, Marquevich V, et al. COVID-19: maintaining essential rehabilitation services across the care continuum. *BMJ Glob Health.* 2020;5.
4. Wosik J, Fudim M, Cameron B, et al. Telehealth transformation: COVID-19 and the rise of virtual care. *J Am Med Inform Assoc.* 2020;27(6):957-962.
5. Gadzinski AJ, Ellimoottil C. Telehealth in urology after the COVID-19 pandemic. *Nat Rev Urol.* 2020;17:363-364.
6. Teasell R, Salbach NM, Foley N, et al. Canadian Stroke Best Practice Recommendations: Rehabilitation, Recovery, and Community Participation following Stroke. Part One: Rehabilitation and Recovery Following Stroke; 6th Edition Update 2019. *Int J Stroke.* 2020:1747493019897843.
7. Winstein CJ, Stein J, Arena R, et al. Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke.* 2016;47:e98-e169.
8. Turan TN, Al Kasab S, Nizam A, et al. Relationship between Risk Factor Control and Compliance with a Lifestyle Modification Program in the Stenting Aggressive Medical Management for Prevention of Recurrent Stroke in Intracranial Stenosis Trial. *J Stroke Cerebrovasc Dis.* 2018;27:801-805.
9. Appleby E, Gill ST, Hayes LK, Walker TL, Walsh M, Kumar S. Effectiveness of telerehabilitation in the management of adults with stroke: A systematic review. *PLoS ONE.* 2019;14:e0225150.
10. Laver KE, Adey-Wakeling Z, Crotty M, Lannin NA, George S, Sherrington C. Telerehabilitation services for stroke. *Cochrane Database Syst Rev.* 2020;2020(1).
11. Tchero H, Tabue Teguo M, Lannuzel A, Rusch E. Telerehabilitation for Stroke Survivors: Systematic Review and Meta-Analysis. *J Med Internet Res.* 2018;20(10):e10867.
12. Saunders DH, Sanderson M, Hayes S, et al. Physical fitness training for stroke patients. *Cochrane Database Syst Rev.* 2020(3).
13. Vahlberg B, Cederholm T, Lindmark B, Zetterberg L, Hellström K. Short-term and long-term effects of a progressive resistance and balance exercise program in individuals with chronic stroke: a randomized controlled trial. *Disabil Rehabil.* 2017;39(16):1615-1622.
14. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. *Int J Soc Res Methodol: Theory Pract.* 2005;8:19-32.
15. Ramage ER, Fini NA, Lynch EA, Patterson A, Said CM, English C. Supervised exercise delivered via telehealth in real time to manage chronic conditions in adults: a protocol for a scoping review to inform future research in stroke survivors. *BMJ Open.* 2019;9:e027416.

16. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018.
17. Higgins J, (Eds) GS. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 *The Cochrane Collaboration.* 2011.
18. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information.* 2018;34:285-291.
19. Bernocchi P, Vanoglio F, Baratti D, et al. Home-based telesurveillance and rehabilitation after stroke: A real-life study. *Top Stroke Rehabil.* 2016;23:106-115.
20. Chen J, Jin W, Dong WS, et al. Effects of Home-based Telesupervising Rehabilitation on Physical Function for Stroke Survivors with Hemiplegia: A Randomized Controlled Trial. *Am J Phys Med Rehabil.* 2017;96:152-160.
21. Galloway M, Marsden DL, Callister R, Nilsson M, Erickson KI, English C. The feasibility of a telehealth exercise program aimed at increasing cardiorespiratory fitness for people after stroke. *Int J Telerehabil.* 2019;11:9-28.
22. Huzmeli ED, Duman T, Yildirim H. Efficacy of telerehabilitation in patients with stroke in Turkey: A pilot study. *Turk Noroloji Derg.* 2017;23:21-25.
23. Lai JC, Woo J, Hui E, Chan WM. Telerehabilitation - a new model for community-based stroke rehabilitation. *J Telemed Telecare.* 2004;10:199-205.
24. Lin KH, Chen CH, Chen YY, et al. 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 (Basel).* 2014;14:12451-12466.
25. Palmcrantz S, Borg J, Sommerfeld D, et al. An interactive distance solution for stroke rehabilitation in the home setting–A feasibility study. *Informatics Health Soc Care.* 2017;42:303-320.
26. Burns PB, Rohrich RJ, Chung KC. The levels of evidence and their role in evidence-based medicine. *Plast Reconstr Surg.* 2011;128:305-310.
27. Cumming TB, Churilov L, Linden T, Bernhardt J. Montreal Cognitive Assessment and Mini-Mental State Examination are both valid cognitive tools in stroke. *Acta Neurol Scand.* 2013;128:122-129.
28. Demain S, Wiles R, Roberts L, McPherson K. Recovery plateau following stroke: fact or fiction? *Disabil Rehabil.* 2006;28:815-821.
29. Ostwald SK, Godwin KM, Ye F, Cron SG. Serious adverse events experienced by survivors of stroke in the first year following discharge from inpatient rehabilitation. *Rehabil Nurs.* 2013;38:254-263.
30. Batchelor FA, Hill KD, Mackintosh SF, Said CM, Whitehead CH. Effects of a multifactorial falls prevention program for people with stroke returning home after rehabilitation: a randomized controlled trial. *Arch Phys Med Rehabil.* 2012;93:1648-1655.
31. Batchelor F, Hill K, Mackintosh S, Said C. What works in falls prevention after stroke?: a systematic review and meta-analysis. *Stroke.* 2010;41:1715-1722.
32. Mackintosh SF, Hill KD, Dodd KJ, Goldie PA, Culham EG. Balance score and a history of falls in hospital predict recurrent falls in the 6 months following stroke rehabilitation. *Arch Phys Med Rehabil.* 2006;87:1583-1589.

33. Piotrowicz E, Piepoli MF, Jaarsma T, et al. Telerehabilitation in heart failure patients: The evidence and the pitfalls. *Int J Cardiol.* 2016;220:408-413.
34. Nicholson SL, Donaghy M, Johnston M, et al. A qualitative theory guided analysis of stroke survivors' perceived barriers and facilitators to physical activity. *Disabil Rehabil.* 2014;36:1857-1868.
35. Marzolini S, Balitsky A, Jagroop D, et al. Factors Affecting Attendance at an Adapted Cardiac Rehabilitation Exercise Program for Individuals with Mobility Deficits Poststroke. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association.* 2016;25:87-94.

Table 1.
Inclusion and Exclusion Criteria

Parameter	Inclusion Criteria	Exclusion Criteria
Population	Stroke Adult, 18 years and older	
Intervention	Supervised[a] exercise[b] delivered via telehealth[c] where: The majority of supervised exercise is delivered via telehealth and this supervision involves observation in real-time (visual, or via other continuous physiologic monitoring) The exercise sessions provide opportunity for participant and health professional feedback to ensure exercises are carried out correctly and safely The exercise delivered involves activities undertaken in weightbearing or standing positions (including walking or pre-walking training)	Exercise delivered to participants located onsite at a health-care facility Exercise occurring with a health professional present at the participant's site (e.g. expert remotely supervising novice health professional on telehealth) Exercise not supervised by a health professional The intervention is primarily aimed at improving arm activity
Comparison	Any	Nil exclusion criteria
Outcome	All	Nil exclusion criteria
Publication type	Published primary research studies, including both qualitative and quantitative research	Text Opinion papers Letters Literature reviews Systematic reviews Meta-analyses Not published in English Protocols Abstracts of unpublished studies Conference papers Case reports

[a]Supervision forms part of the inclusion criteria and is defined as real-time monitoring (visual or through other continuous physiologic monitoring, such as echocardiogram or heart rate) by a health professional with the opportunity for participants to receive and provide health professionals feedback in real time to ensure the exercise is being carried out safely.
[b]Exercise encompasses any weight-bearing (standing) physical activity.
[c]Telehealth is defined as the application of telecommunications and virtual technology to provide health care outside of conventional health care facilities.

Table 2.
Key Characteristics of Included Participants and Telehealth-Delivered Interventions[a]

Study (Country)	Design, n	Participant Characteristics	Intervention (Planned)		Adverse Events Related to the Intervention
			Type	Dose	
Bernocchi et al (2016)[19] Italy	Single group, pre-post n = 26 Dropouts: 3 (12)	Subacute (<12 mo poststroke), n = 15 Chronic (>12 mo poststroke), n = 11 Age, y: 70 (10) Sex, F: 10 (38%) Modified BI: 65 (23)[b] BBS: 32 (13)[b] FIM: 77 (17) Motor FIM: 49 (15) 6MWT: 155 (98)[b] ≥3 cardiovascular risk factors: 17 (65%) Needing support in mobility 19 (73%)	Telehealth exercise: Personalized program and a selection of funtional exercises of the arms, legs and trunk in lying, sitting and standing positions, including walking, turning, stairs and activities of daily living + Unsupervised sessions + Telesurveillance and advice + Tele-psychological support (n = 2) for participants with moderate depression	Supervised: session duration NR x ≥1/wk x 3 mo Intensity not stated	Nil[c]
Chen et al (2017)[20] China	Randomized trial n = 54 Dropouts: 3 (6%) at 12 wk, 1 (2%) at 24-wk (follow-up)	Subacute (14–90 d) Age, y: 66 (12)[d] Sex, F: 21 (39%)[d] NIHSS: 7 (3)[d] Modified BI: 55 (13)[d] BBS: 32 (5)[d] MMSE: 27 (2)[d]	Leg, arm, motor imagery, balance exercises, walking and functional task training + EMG-triggered NMS Exp: via telehealth Con: face to face	Exercise: 60 min x unclear (5 or 10)[e]/wk x 12 wk Intensity not stated EMG-triggered NMS: 20 min x unclear (5 or 10)[e]/wk x 12 wk	Nil
Galloway et al (2019)[21] Australia	Single group pre-post study n = 24 Dropouts: 3 (13%)	Chronic (3 mo–18 y) Age, y: 62 (11)[b] Sex, F: 9 (43%)[b] mRS: range = 0–3[b] MoCA: 25 (3)[b]	Telehealth exercise: Aerobic, (arms and legs) typical exercises included standing up, squats, marching on spot and step ups	10–25 min[c] x 3/wk x 8 wk Intensity moderate to vigorous	1 adverse event: fall during a supervised exercise session requiring medical assistance
Huzmeli et al (2017)[22]	Single group, pre-post	Inclusion criteria did not specify time post-stroke	Telehealth exercise: Exercises in supine, sitting and standing positions	Session duration NR x 3/wk x 3 wk	NR

Turkey	n = 15 Dropouts = 5 (33%)	Age, y: 53 (6)[b] Sex, F: 4 (40%)[b] MMSE: 27 (15–30)[b,f]	for the legs, arms and trunk	Intensity not stated	
Lai et al (2004)[23] Hong Kong, China	Single group, pre-post n = 21 Dropouts = 2 (10%)	Chronic (≥ 6 mo) Age, y: 70 (6) Sex, F: 9 (43%)	Telehealth exercise:Warm up, strength and balance, cool down + Education and social support + Home exercise encouraged ≥ 3/wk	30 min x 1/wk x 8 wk Intensity not stated	NR
Lin et al (2014)[24] Taiwan	Randomized trial n = 24 Dropout = 1 (4%)	Chronic (>6 mo), living in long-term care facility (>3 mo) Age, y: 75 (10)[d,g] Sex, F: 7 (29%)[d,g] BI: 55 (29)[d,g]	Balance training, progressions involving: changing body position (sitting to standing and static to dynamic exercises); changing environment (from firm to foam seat); and using arms Exp = via telehealth (including animation exercise video and interactive touch screen games) Con = face to face	Exp 50 min x 3/wk x 4 wk No planned intensity[h] Con 50 min x 3/wk x 4 wk Intensity not stated	NR
Palmcrantz (2017)[25] Sweden	Single group, pre-post Mixed methods n = 15 Dropout: 1 (7%)	Stroke (subacute or chronic) Age, y: 66 (16) Sex, F: 7 (47%) NIHSS: 4 (0–13)[f] BI: 95 (55–100)[f] MoCA: 24 (11–28)[f]	Telehealth exercise: Leg, arm and balance (weight shifting, steppping and reaching) exercises. Exercises were computer game-based + 9 additional unsupervised sessions	Duration NR x 2/wk x 3 wk Intensity not stated	Nil

[a]Values are reported as mean (SD) unless otherwise stated. BBS = Berg Balance Scale; BI = Barthel Index; Con = control; Exp = experimental; EMG = electromyography; F = female; FIM = Functional Independence Measure; MMSE = Mini-Mental State Examination; MoCA = Montreal Cognitive Assessment; mRS = modified Rankin Scale; 6MWT = 6-min walk test; NIHSS = National Institutes of Health Stroke Scale; NMS = neuromuscular stimulation; NR = not reported.

[b]Data for participants who completed the study only.

[c]Information derived from author correspondence.

[d]Mean (SD) values were calculated from Exp and Con group data using standard formulae.

[e]Undertaken “twice in a working day for 12 weeks, a total of 60 sessions”; however, calculating x 2 (sessions) x 5 (working days) x 12 weeks would equal 120 sessions.

[f]Median (range).

[g]SD based on conversion from SE using standard formula.

[h]Therapist could monitor the sequence and duration with light to moderate exercise intensity (Borg Scale score = 12–14).

Table 3.
Key Barriers and Limitations to Adherence and Satisfaction and Mitigation Strategies[a]

Study	Factors Preventing Participation in Telehealth Trials	Key Factors That May Inhibit Adherence or Experience	Adherence/Satisfaction
Bernocchi et al (2016)[19]	226 of 252 (90%) stroke survivors screened and not eligible included: • 98 (39%) no caregiver available • 23 (9%) poor cognitive status • 17 (7%) unable to videoconference • 7 (3%) unable to undertake telephone contacts • 31 (12%) refused • 50 (20%) other		**Adherence:** not specifically stated; physiotherapist performed 9.5 (2.8) video conference sessions per patient scheduled for once per week from the second week of the 3-mo intervention **Dropouts:** 3 (12%) **Satisfaction:** Of participants regarding the overall service: • 60% very satisfied • 40% satisfied • Access to the service helped patient and family: very much (27%), a lot (40%), enough (27%)
Huzmeli et al (2017)[22]	5 (33%) of participant did not complete the intervention due to technical difficulties	Not reported	Adherence: not stated Dropouts: 5 (33%) Satisfaction: not addressed
Galloway et al (2019)[21]	66 stroke survivors expressed interest 42 (64%) declined or ineligible: • 9 (14%) unable to nominate an adult to be present • 2 (3%) unwilling/ unable/concerned about ability to operate telehealth systems • 2 (3%) not suitable internet	Internet issues (5% of all sessions) Computer issues (2% all sessions) Videoconference software issues (1% all sessions) Lack of audio or visual quality Lack of caregiver support or assistance: 6 (29%) participants reported an inability to independently use the telehealth system: • 4 (19%) technical familiarity score ranked in the lowest third of study participants • 2 (10%) indicated a higher level of physical impairment Some technology aspects (19%) particularly the heart rate monitors Illness, scheduling conflicts, minor injury/soreness	**Adherence:** 476 (94%) of scheduled sessions completed, 408 (85%) of these scheduled sessions completed via telehealth • Videoconference = 372 (78%) • Phone = 20 (4%) • Videoconference and phone = 16 (3%) **Dropouts**: 3 (13%) **Satisfaction:** Of 20 participants who completed the telehealth intervention (1 (5%) participant unable to manage telehealth connection completed the intervention through in-person training) • 95% would recommend program • 100% participants would use telehealth exercise again • 100% agreed (or strongly agreed) they felt safe during sessions 29% would have preferred to exercise in a central venue if they had transport
Chen et al		Not reported	**Adherence:** not stated

(2017)[20]			Dropouts: 3 (6%) prior to the 12-wk evaluation, 1 (2%) further dropout at 24-wk (follow-up) evaluation Satisfaction: not addressed
Lai et al (2004)[23]	Not reported	Not reported	**Adherence**: overall attendance rate = 87% **Dropouts:** 2 (10%) **Satisfaction:** • Participants rated clinical effectiveness of telerehabilitation as good or excellent • No preference for face-to-face or telehealth
Lin et al (2014)[24]	Not reported	Not reported	**Adherence:** not stated **Dropout:** 1 (4%) **Satisfaction:** good, with no significant difference in the common dimensions between face to face and telehealth. Mean telehealth participant ratings ranging from ~3.5 to 4/5 for system environment satisfaction, perceived satisfaction of system, perceived usefulness, perceived ease of use, and attitude towards using the telerehabilitation system
Palmcrantz et al (2017)[25]	Insufficient internet access meant 2 eligible participants were excluded before intervention start (total included participants = 15)	Technical issues including: • Sound and visual quality of the videoconferencing • Difficulties operating the bespoke telehealth system (initially) Difficult and stressful to learn to use the system	**Adherence:** participants performed a mean of 13 of the planned 15 (87%) supervised (6) and unsupervised (9) session. Training session (supervised and unsupervised) duration (min) = 19.5 (9.4) **Dropout**: 1 (7%)

[a]Values are reported as mean (SD) or no. (%).

Table 4.
Key Strategies for Optimizing Safety and Feasibility of Telehealth Intervention[a]

Study	Equipment	Key Participant Inclusion/Exclusion Criteria	Telehealth Exercise Setup and Supervision
Bernocchi et al. (2016)[19]	Videoconferencing system (therapists able to view multiple participants, participants able to view therapist only) DVD: physiotherapist demonstrating activities and stroke education 1 lead electrocardiography device (not used in exercise sessions) Telephone Activity diary	Inclusion: Functional upper limb deficit, no minimum mobility requirement Exclusion: Cognitive deficits and/or the absence of a caregiver to provide informal care for the entire period of home rehabilitation	Exercise prescription conducted face to face Exercise sessions performed at home Caregivers available throughout the intervention period (unclear if all patients had a caregiver as not mandatory requirement if no cognitive deficits) No physiological monitoring during exercise sessions (monitored through separate telesurveillance sessions) Opportunity for group exercise sessions (ratio not described), participants unable to see/hear other participants during group sessions Training re: telehealth equipment not described
Chen et al (2017)[20] China	Videoconferencing system Electronic medical records system (therapist end) Muscle electricity biofeedback instrument, and physiological data collection system and training log (participant end)	Inclusion: Hemiplegia, with motor function adequate to allow participation, with no specific minimum mobility requirement NIHSS scores from 2 to 20 Exclusion: Co-morbidity that may limit safe participation in exercise Glasgow Coma Scale <15 Dementia "based on MMSE assessment" (no specific cut-off number identified), cognitive disorder	Exercise prescription conducted face to face Exercise sessions performed at home Caregivers supervised and assisted exercises at home Physiological monitoring (heart rate, respiratory rate, temperature, blood pressure, oxygen saturation) Health professional to participant ratio appears 1:1 In-person demonstration of telerehabilitation system prior to hospital discharge (and intervention start)
Galloway et al (2019)[21] Australia	Videoconferencing system Physiological monitoring device Telephone	Inclusion: Medical clearance, independent ambulator Access to internet and suitable exercise space Exclusion: Unable to understand 2 simple commands Co-morbidity that may limit safe participation in exercise	Exercise prescription conducted face to face Exercise sessions performed at home Person available at home in case of emergency, assisted participant in some cases Physiological monitoring (heart rate, Borg rating of perceived exertion) Health professional to participant ratio 1:1 Home visit prior to telehealth or risk assessment of exercise

			space, exercise prescription and education re: use telehealth and monitoring equipment
Huzmeli et al (2017)[22] Turkey	Videoconferencing system	Inclusion: Able to comprehend and follow verbal instructions Video communication equipment at home 3rd or higher Brunnstrom stages No minimum mobility requirement Exclusion: nil	Exercise prescription conducted face to face Exercise sessions performed at home Caregivers supervised or assisted exercises at home No physiological monitoring Health professional to participant ratio 1:1 Training re: telehealth equipment not described
Lai et al (2004)[23] Hong Kong, China	Videoconferencing system Two screens allowed viewing of a slide presentation and the clinician (on separate screens) Exercise logbook	Inclusion: Independent ambulator Exclusion criteria: MMSE score of <18, significant communication barriers Co-morbidity that may limit safe participation in exercise	Exercise prescription: NR Exercise sessions performed in community centre No in-person supervision of exercises, volunteer to assist with running of session Physiological monitoring (blood pressure and heart rate measured pre and post session) Health professional to participant ratio 1:6–8 Training re: telehealth equipment not described
Lin et al (2014)[24] Taiwan	Bespoke telehealth system including: - Videoconferencing -Physiological monitoring with therapist able to view vital signs on their screen - Participant has two screens (one for video communications and one touch screen)	Inclusion: Active movement in the proximal upper limb (Brunnstrom stage upper extremity ≥ 3) Able to sit without hand support for ≥30 s Able to follow instruction (cognitive screen using Mini-Cog test) Able to communicate and follow 3-step command Exclusion: Blindness or deafness Co-morbidity that may limit safe participation in exercise	Exercise prescription (in-person or remotely): NR Exercise sessions performed in long term care facility Volunteer or non-medical person supervised or assisted with the program in the care facility Physiological monitoring (heart rate, blood pressure and oxygen saturation, Borg rating of perceived exertion) Health professional to participant ratio 1:2 Training re: telehealth equipment not described
Palmcrantz (2017) Sweden	Bespoke telehealth system including: - Videoconferencing (with large screen for participant) - Motion capture system (Kinect sensor) to facilitate evaluation of exercises	Inclusion: Impaired motor function after stroke limiting ADLs Ability to stand without support >2 min and perform a forward reach >12 cm (this criterion was introduced after the enrolment	Exercise program devised using information from face to face assessment and performance of the prototype exercise (program introduced and evaluated at the first telehealth session) Exercise sessions performed at home In-person supervision of exercises by caregiver not reported

		of the 3rd participant) Exclusion: Severe cognitive and/or speech impairment limiting the ability to follow instructions Impaired vision preventing orientation and reading instructions on a screen Co-morbidity that may limit safe participation in exercise Limited internet access	Checking 'safety aspects' of exercise (especially in the first week and when exercises were altered) No physiological monitoring Health professional to participant ratio 1:1 Home visit prior to telehealth delivery also included: Technology installed in patient's homes by technician and physiotherapist (advised where to do exercises), instruction re: telehealth equipment

[a]Key strategies identified by the research team only; for further information on strategies, see individual studies (eg, comprehensive list on inclusion/exclusion criteria and equipment used). ADLs = activities of daily living; MMSE = Mini-Mental State Examination; NIHSS = National Institutes of Health Stroke Scale; NR = not reported.

Table 5.
Effectiveness of Telehealth-Delivered Exercise[a]

Outcome	Group				Difference Within Group(s)[b]: Postintervention Minus Baseline		Difference Between Group(s)[b] Post intervention
	Baseline		Postintervention				
Chen et al (2017)[20 c]	Exp (n = 27)	Con (n = 27)	Exp (n = 26)	Con (n = 25)	Exp	Con	Exp minus Con
Modified Barthel Index (score, range = 0–100)	55.6 (12.8)	54.3 (13.4)	61.4 (12.9)	59.8 (12.3)	5.8 (-1.3 to 12.9)	5.5 (-1.7 to 12.7)	1.6 (−5.5 to 8.7)
Berg Balance Scale (score, range = 0–56)	33.1 (4.0)	31.7 (5.9)	37.0 (3.8)	36.1 (5.3)	**3.9 (1.8 to 6.1)**	**4.4 (1.3 to 7.5)**	0.9 (−1.7 to 3.5)
Caregiver Strain Index (score, range = 0–13)	6.0 (1.7)	6.3 (2.5)	4.2 (1.5)	4.5 (2.1)	**-1.8 (-2.7 to –0.9)**	**-1.8 (-3.1 to -0.5)**	-0.3(-1.32 to 0.72)
Lin et al (2014)[d 24]	Exp (n = 12)	Con (n = 12)	Exp (n = 12)	Con (n = 12)	Exp (n = 12)	Con (n = 12)	Exp minus Con
Berg Balance Scale (score, range = 0–56)	20.4 (17.0)	22.4 (18.4)	24.6 (18.4)	26.9 (18.0)	4.2 (-10.8 to 19.2)	4.5 (-10.9 to 19.9)	-2.3 (-17.7 to 13.1)
Barthel Index (score, range = 0–100)	52.9 (32.9)	57.9 (26.7)	57.9 (3.1)	60.8 (22.5)	-5.0 (-14.8 to 24.8)	2.9 (-18.0 to 23.8)	-2.9 (-16.5 to 10.7)
Self Care (subscore range = 0–40)	36.7 (18.7)	39.2 (18.6)	40.0 (17.3)	41.3 (14.5)	3.3 (-12.0 to 18.6)	2.1 (-12.0 to 16.2)	-1.3 (-14.8 to 12.2)
Mobility (subscore range = 0–60)	16.3 (15.9)	18.8 (11.9)	17.9 (15.9)	19.6 (311.1)	1.6 (-11.9 to 15.1)	0.8 (-8.9 to 10.5)	-1.7 (-13.1 to 9.9)
Lai et al (2004)[23]	n = 19		n = 19				
Berg Balance Scale (score, range = 0–56)	42.2 (6.7)		49.0 (6.5)		**6.8 (2.5 to 11.1)**		
36-Item Short Form Health Survey (SF-36); each item score range = 0–100							
Physical functioning	49.0 (15.7)		71.6(21.7)		**22.6(10.1 to 35.1)**		
Role, physical	18.4(32.1)		79.0(41.9)		**60.6(36.0 to 85.2)**		

Bodily pain	57.4(29.3)	86.0(24.3)	**28.6 (10.9 to 46.3)**		
General health	35.0(20.3)	53.2(17.7)	**18.2(5.7 to 30.7)**		
Vitality	40.8(16.3)	66.3(17.7)	**25.5(14.3 to 36.7)**		
Social functioning	68.4(22.2)	88.8(19.5)	**20.4(6.7 to 34.2)**		
Role, emotional	45.6(38.8)	93.0(23.8)	**47.4(26.2 to 68.6)**		
Mental health	65.3(22.2)	77.7(17.4)	12.4(-0.7 to 25.5)		
State of Self-Esteem Scale (score, range = 5–100)	64.8 (12.3)	79.8 (12.8)	**15.0 (6.7 to 23.2)**		
Stroke knowledge test (score, range = 0–10)	4.8(1.7)	8.7(1.5)	**3.9(2.9 to 5.0)**		
Bernocchi et al (2016)[19]	n = 23	n = 23			
Berg Balance Scale (score, range = 0–56)	32 (13)	42 (13.8)	**10 (2.3 to 17.7)**		
Tinetti Scale (score, range = 0–28)	4(2.8)	6(3)	**2(0.3 to 3.7)**		
Modified Barthel Index (score, range = 0–100)	65(22.5)	85(22.5)	**20(6.63 to 33.7)**		
6-min walk test, m (n = 15)	155(98)	210(85)	55(-13.3 to 123.4)		
Motricity Index paretic side (score, range = 0–100)	55(15.16)	74.5(22.6)	**19.5(8.1 to 30.9)**		
Huzmeli et al (2017)[22]	Median (range) (n = 10)	Median (range) (n = 10)			*P*
Berg Balance Scale (score, range = 0–56)	35 (18 to 48)	36.5 (21 to 50)			**.03**
36-Item Short Form Health Survey (SF-36); each item score range = 0–100					
Physical functioning	42.5 (0 to 65)	42.5 (0 to 75)			.18
Physical role limitation	12.5 (0 to 100)	12.5 (0 to 100)			1.0
Bodily pain	36.5 (10 to 84)	37 (12 to 84)			.89

General health perceptions	40 (10 to 77)	48.5 (10 to 72)			.07
Vitality	57.5 (30 to 85)	55 (30 to 85)			.56
Social role functioning	25 (0 to 75)	37.5 (0 to 75)			.10
Emotional role functioning	0 (0 to 100)	0 (0 to 100)			.32
Mental health	72 (48 to 80)	70 (48 to 76)			.24
Mini-Mental State Examination	26.5 (15 to 30)	28 (15 to 30)			.07

[a]Mean (SD) of groups, mean (SD) difference within groups, and mean (95% CI) difference between groups unless otherwise stated. Bold type indicates statistical significance. Con = control; Exp = experimental.
[b]Within- and between-group mean differences and 95% CIs were calculated from baseline and postintervention means and SDs using standard formulae.
[c]Postintervention data reported here were for the 12-wk assessment (not the 24-wk follow-up assessment).
[d]Calculations from this study were based on conversion of the SE to the SD using a standard formula.

Figure

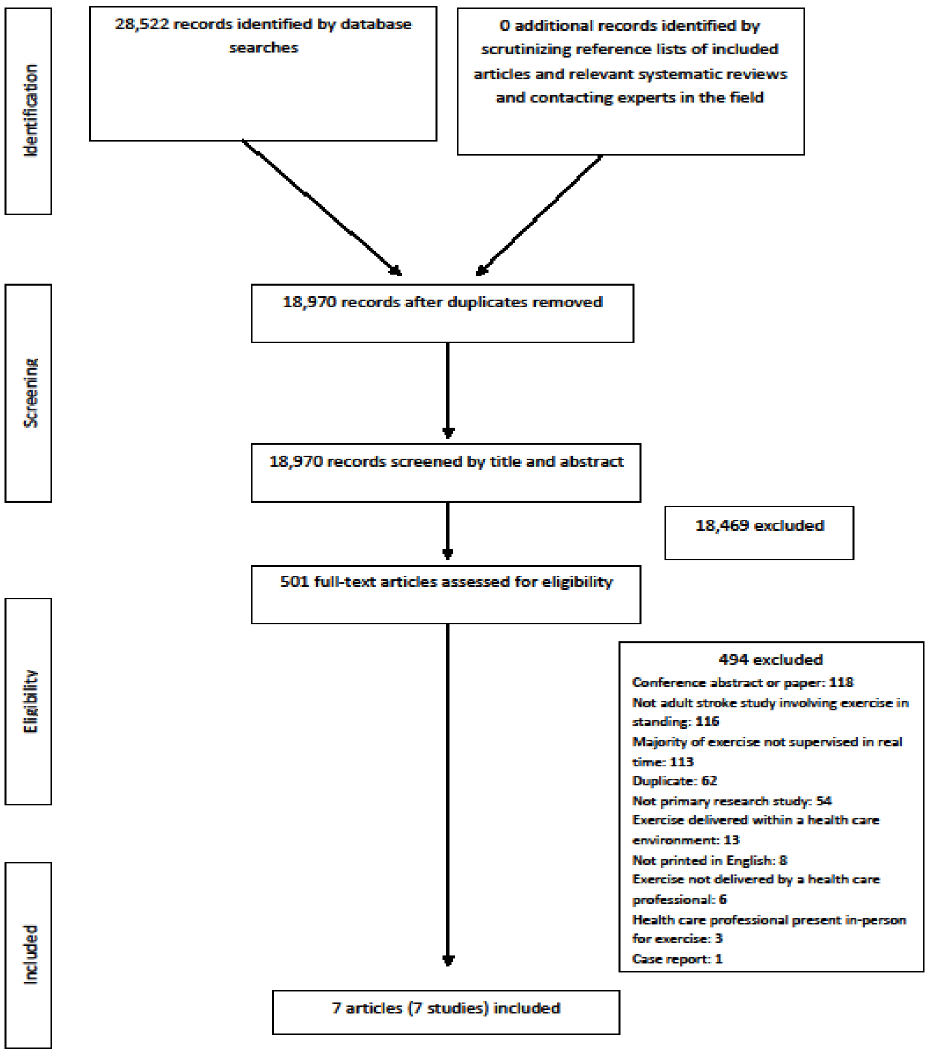
Identification
Screening
Eligibility
Included
28,522 records identified by database searches
0 additional records identified by scrutinizing reference lists of included articles and relevant systematic reviews and contacting experts in the field
18,970 records after duplicates removed
18,970 records screened by title and abstract
18,469 excluded
501 full-text articles assessed for eligibility
494 excluded
Conference abstract or paper: 118
Not adult stroke study involving exercise in standing: 116
Majority of exercise not supervised in real time: 113
Duplicate: 62
Not primary research study: 54
Exercise delivered within a health care environment: 13
Not printed in English: 8
Exercise not delivered by a health care professional: 6
Health care professional present in-person for exercise: 3
Case report: 1
7 articles (7 studies) included

Figure ~~1~~.
Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart.