BMJ Open

Development of strategies to support home-based exercise adherence after stroke in Low- and Middle-income Countries: A Delphi Consensus

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-055946
Article Type:	Original research
Date Submitted by the Author:	30-Jul-2021
Complete List of Authors:	Mahmood, Amreen; Manipal Academy of Higher Education, Physiotherapy; KMC Mangalore, Physiotherapy Deshmukh, Anagha; Manipal College of Health Professions, Clinical Psychology Natarajan, Manikandan ; Manipal College of Allied Health Sciences, Physiotherapy Marsden, Dianne ; Hunter New England Local Health District Vyslysel, Glade; Hunter New England Local Health District Padickaparambil, Sebastian; Manipal College of Allied Health Sciences, Department of Psychology TS, Shwetha; Manipal Academy of Higher Education, Department of Clinical Psychology Direito, Artur; University College London, Health Psychology Kumaran, Senthil ; Manipal College of Health Professions, Physiotherapy N, Girish; Manipal College of Health Professions, Physiotherapy Sachdev, Harpreet ; All India Institute of Medical Sciences, Neurology Kumar Veluswamy, Sundar; MS Ramaiah Medical College Karthikbabu, Suruliraj ; Manipal College of Health Professions Unnikrishnan, B.; Department of Community Medicine, Kasturba Medical College (Manipal University) , Mangalore, India . English, Coralie; University of Newcastle, School of Health Sciences Solomon, John; Manipal College of Allied Health Sciences, Physiotherapy
Keywords:	Stroke < NEUROLOGY, Rehabilitation medicine < INTERNAL MEDICINE, Stroke medicine < INTERNAL MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Development of strategies to support home-based exercise adherence after stroke in Low- and Middle-income Countries: A Delphi Consensus

A. Author and co-authors' name

Amreen Mahmood, Anagha Deshmukh, Manikandan Natarajan, Dianne Lesley Marsden, Glade Vyslysel, Sebastian Padickaparambil, Shwetha Tumkur Shivakumar, Artur Direito, Senthil D. Kumaran, Girish Nandakumar, Harpreet Sachdev, Sundar Kumar Veluswamy, Suruliraj Karthikbabu, Bhaskaran Unnikrishnan, Coralie English, John M. Solomon

B. Corresponding Author Details

Dr. John Solomon M,
Coordinator, Centre for Comprehensive Stroke Rehabilitation and Research,
Head & Associate Professor, Department of Physiotherapy,
Manipal College of Health Professions,
Manipal Academy of Higher Education, Manipal, Karnataka, India
Mail id: john.solomon@manipal.edu

Phone no: +919945670671

Permanent address: Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka, India. Pin code: 576104

C. The full names, institutions, city, and country of all co-authors

1. **Amreen Mahmood**, 1-Department of Physiotherapy, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India. 2 - Department of

Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

2. **Anagha Deshmukh**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

3. **Manikandan Natarajan**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

4. **Dianne Lesley Marsden**, 1-Hunter Stroke Service, Hunter New England Local Health District, New Lambton Heights, NSW, Australia. 2-Priority Research Centre Stroke and Brain Injury, University of Newcastle, Callaghan, NSW, Australia. 3-Brain and Mental Health Program, Hunter Medical Research Institute, New Lambton Heights, NSW, Australia. 4-Centre of Research Excellence in Stroke Rehabilitation and Brain Recovery, Newcastle and Melbourne, Australia.

5. **Glade Vyslysel**, Westlakes Community Rehabilitation Team, Hunter New England Local Health District, NSW, Australia

6. **Sebastian Padickaparambil**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

7. **Shwetha Tumkur Shivakumar**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

8. **Artur Direito**, 1-UCL Centre for Behaviour Change, University College London, London, UK. 2-Yong Loo Lin School of Medicine, National University of Singapore, Singapore.

9. **Senthil D. Kumaran**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

10. **Girish Nandakumar**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

11. **Harpreet Sachdev**, Department of Neurology, All India Institute of Medical Sciences, New Delhi, India.

12. **Sundar Kumar Veluswamy,** Department of Physiotherapy, Ramaiah Medical College, Bengaluru, India.

13. **Suruliraj Karthikbabu,** Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Bengaluru, India.

14. **Bhaskaran Unnikrishnan,** Department of Community Medicine, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India.

15. **Coralie English**, School of Health Sciences and Priority Research, Centre for Stroke and Brain Injury, University of Newcastle, Newcastle, Australia.

16. **John M. Solomon**, 1- Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India. 2 - Centre for Comprehensive Stroke Rehabilitation and Research, Manipal Academy of Higher Education, Manipal, India.

D. Keywords

Developing Countries; Home-based exercises; Patient-Centered care; Patient Compliance; Stroke rehabilitation

E. Word count (excluding title page, references, figures)

3824

Abstract

Objective: To develop a set of strategies to enhance adherence to home-based exercises after stroke, and an overarching framework to classify these strategies.

Method: We conducted a four-round Delphi consensus (two online surveys, followed by a focus group then a consensus round). The Delphi panel included 13 experts from Physiotherapy, Occupational Therapy, Clinical Psychology, Behavior Science, and Community Medicine. The experts were from India, Australia, and United Kingdom.

Results: In round 1, a 10-item survey using open-ended questions was emailed to panel members and 75 strategies were generated. Of these, 25 strategies required further consideration and were included or excluded in round 2. A total of 64 strategies were finally included for the subsequent rounds. In round 3, the strategies were categorized into nine domains – i) education on stroke and recovery, ii) method of exercise prescription, iii) feedback and supervision, iv) cognitive remediation, v) involvement of family members, vi) involvement of society, vii) promoting self-efficacy, viii) motivational strategies and ix) reminder strategies. The consensus from 12 experts (93%) led to the development of the framework in round 4.

Conclusion: We developed a framework of comprehensive strategies to assist clinicians in supporting exercise adherence among stroke survivors. It provides practical methods and can be deployed in both research and clinical practices. Future studies should assess the experiences of stakeholders with the set of strategies. The set of strategies can be incorporated for delivering telerehabilitation and cost effectiveness can be evaluated in future.

Strengths and limitations of this study

- The multidisciplinary expert panel consisted of specialists in exercise prescription, behavior science, and community having diverse experiences that contributed to developing a multi-faceted framework of strategies
- The focus of this study was to develop strategies specific to low- and middle- income countries that are affordable and provide practical methods of implementation
- Individuals with stroke and their caregivers were not included in the Delphi panel
- There was an unequal representation of experts from different specialty

INTRODUCTION

Stroke is one of the leading causes of death and disability in India.[1] Rehabilitation is recommended to promote recovery, enhance independence, and improve quality of life after a stroke.[2,3] However, healthcare services, and comprehensive stroke rehabilitation centers are often expensive and beyond people's reach.[4,5] Considering the limited access to hospital-based healthcare services after stroke,[4] home-based rehabilitation is often preferred, and sometimes the only option for stroke survivors living in low resource settings.[6,7] Home-based rehabilitation has been shown to have functional and cost benefits.[8,9] Adherence to the home-based regimen is of utmost importance for any intervention to be beneficial.[10,11] Improving adherence to exercise program after stroke has shown improvement in functional recovery. [12]

Non-adherence to physical exercises is a common problem among stroke survivors.[13] The level of adherence to prescribed home-based exercises among Indian stroke survivors was found to be only 28%.[14] Limited access to health professional support may reduce the motivation to engage in regular home-based exercises after stroke.[15] Barriers to exercise adherence after stroke include factors at the individual, interpersonal, organizational, and community levels.[16] Lack of knowledge about stroke, lack of supervision and motivation, inadequate exercise prescription by healthcare providers are some modifiable factors of non-adherence.[16,17,18] Other factors leading to non-adherence are physical impairments such as pain, fear of falls, and post-stroke fatigue.[19,20] Environmental factors such as cost, access, and transport have been reported as barriers for people with chronic stroke to accessing health services, thus strategies to support home-based exercises are important in the long term.[20] As stated by the World Health Organization, "increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments." [21] Therefore, improving adherence to post-stroke rehabilitation can enhance recovery and improve the quality of life among stroke survivors.[22]

It is reported that exercise adherence can be improved through motivational interventions, behavioral change strategies, multimedia, follow-up sessions, feedback, cognitive behavior therapy, skill training, self-monitoring, goal setting, coping strategies, and coaching.[22,23,24] However, there is limited information on how to practically incorporate these into clinical practice. Therefore, developing effective strategies for promoting exercise adherence is essential.[12,15] Strategies that identify barriers to adherence, and modify those barriers, can be practically implemented for stroke survivors and have the potential for improving exercise adherence.[25] Thus, we aimed to develop a set of strategies to facilitate adherence to home-based exercises after stroke and a comprehensive framework to classify these strategies.

METHODS

We obtained approvals from the Institutional Research Committee and Institutional Ethics Committee (IEC:355/2017) of Kasturba Hospital, Manipal, India for conducting this study.

Participant recruitment

Participants were recruited using purposive sampling. The criteria for selecting the experts were: i) expertise in stroke/ behavior change/ community health, ii) having more than ten years of clinical experience, iii) published in peer-reviewed journals, iv) involvement in translational and collaborative health research and v) employed in academia, research or clinical practice.

We identified the experts through the collaborative network of the Centre for Comprehensive Stroke Rehabilitation and Research at the Manipal Academy of Higher Education. We aimed to recruit the majority of experts from India to ensure suggestions were context-specific to Low-to-Middle-Income Countries. We invited experts to participate in the study from different fields (Physiotherapy, Occupational Therapy, Neurology, Clinical Psychology, Community Medicine, and Behavior Science) to ensure that the strategies were comprehensive and covered multiple aspects of adherence.

Experts were invited via emails. Those who agreed to participate gave their written consent and were included in the study. We conducted a four-round Delphi consensus;- two online surveys, followed by a focus group to build a set of adherence strategies for home-based exercises based on survey results, then a final online consensus round.[26] Each round lasted for two months. Experts who did not respond even after a biweekly reminder were excluded from that round. Except for the focus group, the experts were blinded to each other for all rounds, and responses were anonymous. The duration of the Delphi rounds was from January 2018 to December 2018. The primary investigator, an experienced stroke physiotherapist (AM) collected and analyzed the data. The focus group was conducted by another investigator (JS) who has more than 15 years of experience in neurological rehabilitation and qualitative studies.

Data collection and analysis

Round 1

Our previous study explored the potential barriers to home-based exercise adherence among stroke survivors through in-depth interviews.[16] Using this information, we categorized the

barriers reported by the stroke survivors into internal and external factors using the Intervention Mapping approach.[25] We also performed a literature search in PubMed, Scopus, Web of Science, and Cochrane using the search terms "physical exercises," "adherence," "compliance," "behavior change," and "health behavior." We reviewed studies from the bibliographies of the relevant articles. We identified health behavior change theories and existing strategies/interventions used for improving adherence to long-term therapies. Our review of the literature led to identifying common principles for supporting adherence such as motivation, self-efficacy, social support, the role of family, online health support (mHealth), and behavior change techniques. [28,29,30,31,32,33,34] Our findings from the literature and our qualitative study were combined to form the 10-item survey using open-ended questions in SurveyMonkey software (https://www.surveymonkey.com/). The survey was then emailed to the expert panel (Supplementary file 1)

For analyzing the round 1 data, we merged the experts' written responses to perform content analysis[35] and coded the responses using Atlas.Ti8 software. The responses that were suggested by more than nine out of 13 (70%) experts were considered as 'certain strategies.' Responses that were not common and suggested by less than nine experts were labeled 'uncertain strategies' for further consideration in round 2.

Round 2

The second survey, consisting of only the ‘uncertain strategies’, was emailed to the expert panel, and they were asked to agree/disagree on the given strategies, and provide reasons for their opinion. For an ‘uncertain strategy’ to become a ‘certain strategy” it needed to have a majority agreement, i.e., six out of 11 experts. This process results in a final set of 64 strategies.

Round 3

We then conducted a face-to-face focus group to collate the included strategies into broader categories. The expert panel was asked to categorize the list of strategies into a specific domain. They also suggested practical ways of implementing the suggested strategies such as – who should design it, the content, how it should be delivered, and towards who the strategies were to be targeted. The remaining experts, who could not be present at the focus group, were emailed the categories and were requested to evaluate the draft framework.

Round 4

The framework of strategies was sent to all the experts for minor modifications and approval. The consensus from the experts led to the development of the final framework. Figure 1 shows the development of the framework.

Patient and Public Involvement

The present study was conceived to provide guidance to facilitate adherence to home exercise programs. As a first step, it was felt important to understand patient experiences in exercise adherence. Towards this end, qualitative interviews were conducted among community-dwelling stroke survivors to explore their exercise behavior and barriers to exercise adherence. The patients' opinions highlighted that not only patient-related factors but family, healthcare system, and community level factors played a role in exercise non-adherence. This information was used in the development of open-ended questions that were asked to subject

experts for the first round of the Delphi process. Therefore, the patients' perceptions and needs were incorporated in this study for designing adherence strategies and framework. After the strategies were developed by experts, they were tested in a subsequent RCT which showed that these strategies significantly improved exercise adherence levels among stroke survivors.

RESULTS

We invited 22 experts across India and abroad to participate in the Delphi survey. Only 13 experts consented to participate in the study and responded to round one (Figure 2). The final panel consisted of physiotherapists (n=7), clinical psychologists (n=3), occupational therapist (n=1), behavior scientist (n=1), and epidemiologist (n=1). Three experts were from Australia, one from the UK, and the remaining experts were from India. Each panel member had more than ten years of clinical experience and multiple publications. (Table 1)

Table 1: Details of participants

Participants	Qualification	Area of work	Expertise	Country
1	Epidemiologist	Research, Academic	Community and rural health Associated with the World Health Organization, Indian Council of Medical Research, and Global Burden of Disease Network	India
2	Occupational Therapist	Clinical	Stroke care and activities of daily living	Australia
3	Physiotherapist	Research, Academic	Stroke rehabilitation and physical activity. Associated with the World Stroke Organization, Stroke Recovery and Rehabilitation Roundtable, and Priority Research Centre for Stroke and Brain Injury	Australia
4	Physiotherapist	Research	Stroke and cardiorespiratory fitness. Associated with the World Stroke Organization and Priority Research Centre for Stroke and Brain Injury	Australia
5	Physiotherapist	Clinical	Stroke rehabilitation	India
6	Physiotherapist	Research, Academic	Stroke rehabilitation	India
7	Physiotherapist	Research, Academic	Community Physiotherapy, and technology in rehabilitation	India
8	Physiotherapist	Research, Academic, Clinical	Physical activity epidemiology	India
9	Physiotherapist	Research, Academic, Clinical	Stroke rehabilitation	India
10	Behavior scientist	Research	Behavior change evidence and theories. Designing and evaluation of behavior change interventions	UK
11	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India
12	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India
13	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India

Round 1

Thirteen experts responded to round one and formed the Delphi panel. The open-ended survey and the summary of responses received in the first round are provided in supplementary file 1. The content analysis of the responses received in round one yielded a total of 75 strategies. Of these, more than nine experts suggested fifty strategies; thus, they were considered 'certain.' Less than nine experts suggested 25 strategies, and those were considered 'uncertain' strategies.

Round 2

The response rate for round two was 85% (11 experts.) Frequency analysis yielded 14 uncertain strategies that were agreed upon by most experts (6 out of 11.) The remaining 11 strategies were excluded. The percentage of agreement for each uncertain strategy is provided in supplementary file 2. We included a total of 64 strategies (50+14) for the subsequent rounds.

Round 3

Six experts (three clinical psychologists, two physiotherapists, and one epidemiologist) participated in the face-to-face focus group. The remaining seven experts responded via emails and provided inputs on the framework. The final 64 strategies were grouped into nine domains (Table 2).

278 **Table 2: Grouping of strategies into specific domains**

Items	Domains	Strategies
1	**Education about stroke and recovery**	• Education about stroke and its treatment • Education on adherence • Caregiver education and involvement • Written instructions & pictures • Testimonials from recovered patients • Information on support agencies • Benefits of exercise • Psychoeducation
2	**Exercise prescription**	• Written instructions & pictures • Videos of exercises • Task-oriented training • Prioritizing on a few tasks at a time • Meaningful and relevant exercises • Breaking down exercises into smaller steps • Individualized program • Fun and engaging exercises • mHealth apps • Demonstrate and practice exercises
3	**Feedback and supervision**	• mHealth apps • Activity log • Feedback from patients • Feedback on their progress • Exercise charts with video/audio recording • Asking to tell approach • Clearing doubts by the medical team • Regular contact with therapists • Recording exercises for feedback

		• Regular monitoring • Understand previous exposure with exercises
4	**Cognitive remediation**	• Educating on the benefits of exercise • Motivational interviewing • Cognitive Behavior Therapy techniques • Behavioral activation • Contingency charts • Involving group sessions • Meaningful tasks • Psycho education

5	**Involvement of family members**	• Exercise buddies • Emotional support • Assessing knowledge and understanding of the family on the importance of exercise • Rotate family members in care giving • Activity scheduling
6	**Involvement of society**	• Involvement of friends • Involving group sessions • Modeling behavior • Support and exercise groups • Social comparison
7	**Promoting self-efficacy**	• Personal graph charts • Reduce the number of alternatives presented to the patient • Provide activities that can be done independently • Standardized assessment • Goal setting • Self-efficacy enhancement: using substitution and optimization principles • Ongoing support • Methods of tracking exercises • Coaching methodology • Psycho education
8	**Motivational strategies**	• Patient's videos to show improvement • M-Health • Interim assessments • Feedback on progress – importance to micro gains • Positive log diary • Wall of fame/display board • Provide tokens and badges for improvement • Methods of education & counseling

		• Devise color bands (coded for level of recovery) • Intra-group competition • Avoid direct comparison
9	**Reminders strategies**	• Reminder phone calls • Use of media • Sticky notes • Alarms/music clips • Auditory - use voice recording during therapy sessions • Logbook • Posters in the waiting area for hospital settings • Whatsapp (or similar) for reminder

Round 4

The final framework of strategies for improving home-based exercise adherence was agreed upon by 12 (93% response rate) experts. The experts agreed that the exercise-related strategies should be designed and delivered by therapists having experience in stroke care such as an occupational therapist, physiotherapist, physiatrist, or stroke nurse. They suggested that the strategies requiring behavioral techniques should be designed and supervised by a licensed clinical psychologist or behavior therapist. In the following section, we have highlighted the key suggestions from the expert committee under each domain. The details of the framework are provided in supplementary file 3.

Strategies for improving adherence to home-based exercises post-stroke under each domain

Domain I - Education on stroke and recovery

Experts agreed that the education should comprise of – i) usual time course and speed of recovery, ii) the impact of practice and exercise on recovery, iii) adverse effects of rest and positive effects of activity, iv) the importance of secondary risk factor management, v) managing complications (e.g., spasticity, pain, fatigue, contracture, depression), vi) interventions without evidence (including traditional medicines and religious practices), vii) adherence to the exercise program, dosage of the exercise program, viii) role of a caregiver, ix) recovery and return (interaction between severity and prognosis), x) proper positioning techniques, and xi) misconceptions about stroke recovery.

Methods recommended for delivering education included: written information, individual discussions, and phone calls that are individually tailored to each patient's needs,

as well as conducting group sessions wherein testimonials from recovered patients and their caregivers are presented.

Domain II – Methods of exercise prescription

Exercises that are prescribed should be task-specific and individually tailored based on each persons' impairments, goals, and context. These exercises should be reinforced using demonstration and practice. Exercise prescription should include personalized information or messages of personal encouragement.

Additional ways for prescribing exercises may include written or pictorial instructions, videos of exercises, voice-assisted programs, or internet-based applications. Other ways that can support adherence are video recording of patients' exercise performance, splitting the exercise into smaller steps for severe impairments, and gradually increasing difficulty level. Gaming or gamification may also facilitate exercise adherence since it gives a sense of achievement and reinforces exercise behavior.

Domain III - Feedback and supervision

For regular feedback and supervision, maintaining an exercise log or everyday activity status, or updates that are monitored by the medical team could be useful for supporting adherence. Having therapists clear any doubt that patients might have about their exercise prescription, routinely ask patients about their progress, and periodically ask patients to give feedback about the quality of their interaction with therapists will provide a sense of supervision and accountability, thus facilitating adherence.

There should be regular contact with the therapists (in person or via telehealth.) Therapists can use recorded audio/video clips, individual or group discussions for feedback and supervision. Therapists should use standardized assessments to measure clinical outcomes and provide feedback on progress.

Domain IV - Cognitive remediation

The experts in behavioral science and cognitive rehabilitation agreed on prescribing tasks that are focused on functional recovery, planning the exercise centered on individual goals, and understanding the patient's motivation before the treatment session. Motivational interviewing or Motivation Enhancement Therapy could be used to understand their baseline motivational level and establish intrinsic motivation for behavior change. Providing positive feedback and reinforcement for small improvements engenders confidence in patients. Additionally, having a contingency plan for days when exercises could not be performed would prevent abrupt cessation of exercise routine. Using behavioral activation so that patients perform one enjoyable activity each day would keep them motivated for sticking to exercise schedule.

Domain V - Involvement of the family members

Experts suggested that the family should be involved; however, the amount of assistance provided by the family needs to be balanced so as not to promote dependency. Assessing knowledge and understanding of the caregivers on post-stroke exercises is crucial for them to reinforce patients' adherence. Family can be involved by being the patient's exercise partners, or by setting up exercise reminders, or by helping track the patient's progress. Demonstrating

and practicing exercises with family can also enhance the self-efficacy and confidence of caregivers.

Managing the expressed emotions of the family members is important as it may hinder treatment and restrict the patient's autonomy. Rotating family members in the supervision of the patient's activities can help in reducing burnout and maintain novelty in routine.

Domain VI - Involvement of society/ community

Family and friends can interact with the patient on topics not concerning the illness (areas of interest to the patient such as work/ politics/ current affairs/ sports.) Some strategies for involving society include having weekly phone/face-to-face interactions with colleagues, family, and friends, or joining/ creating support groups or associations of families with stroke. Testimonials of recovered patients and their experiences with rehabilitation can be used for motivating other patients. Additional ways to include community are awareness programs for healthy adults, local group exercise for people with stroke, and peer support or exercise buddies.

Domain VII - Promoting self-efficacy

Experts suggested using evidence-based behavior change strategies (e.g., the Capacity Opportunity Motivation-Behavior model[36], or Intervention Mapping approach[25]) and using rehabilitation principles of substitution and optimization. Some suggested strategies to promote self-efficacy include

- Collaborating with patients to devise the best monitoring strategy for them such as exercise practice sheets, paper, electronic diary, or internet-based applications.

- Providing continual support after the termination of the formal therapy program.
- Providing personal graph charts of success that can be generated weekly or monthly.
- Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision.
- Identifying anchors in the day (sleep times/meals/activities - exercise, recreation, social) and setting a general intention of sticking to their exercise program, or developing contingency "if/then" plans.
- Discuss and explore potential barriers that would impede or hinder exercise sessions with patients.
- Overcome barriers using pie-charts, pros versus cons analysis/ identification of cognitive distortions/ downward arrow techniques/ developing a life brochure/ movement, or art-based therapeutic activities.
- Motivation interviewing to help to elicit patients' intention to adhere to exercises and understand their motivation level.

Domain VIII - Motivational strategies

Panel experts suggested that motivation can be facilitated by establishing positive feedback mechanisms at home with caregivers' help to reward adherence. Motivational strategies can be implemented as follows:

- Showing functional improvements or devising individual graphs (every three sessions plus monthly.)
- Having a display board/wall of fame where 'patient of the month' and photos of patients achieving good outcomes could be displayed in a rehabilitation center or common m-health application.

- Using productivity monitor tools to keep them motivated.
- Maintaining a positive log and telephonic follow-up where the medical team provides words of encouragement can promote adherence.
- Having video feedback at regular intervals, setting progressive but attainable targets, and involving patients in goal setting may motivate patients to continue exercising.
- Devising color bands (coded for level of recovery and mastery of tasks)
- Giving t-shirts or wrist bands of that color and upgrading as they progress to encourage regular exercising.
- Competitions during group sessions among people with similar impairments and provide tokens or badges for improvement that can be exchanged for tangible rewards to make exercising fun and interesting.
- Having an interactive internet-based community where people can add friends to motivate each other to exercise can also be a solution in times of social distancing.

Domain IX - Reminders strategies

Experts agreed on reminder strategies including:

- Calling patients regularly and visiting them weekly or fortnightly.
- Using sticky notes in the patients' homes, tally sheets, pamphlets, or SMS/WhatsApp reminders.
- Therapists using videos to show the exercise steps and prescribe the same for home practice.
- Use of technology such as sending small feedback surveys, disease information, scientific literature, and progress cards to keep the patients engaged and motivated to continue exercises.

- Using daily logs (electronic or paper-pencil) and weekly reviewing the exercise log to help stick to a schedule.

DISCUSSION

We aimed to develop a comprehensive set of clinically applicable strategies for optimizing adherence to home-based exercises after a stroke. In a Delphi method, experts from different fields co-construct knowledge and provide recommendations on a particular topic.[37] In our study, we incorporated knowledge from experts in exercise science, behavior science, and experts experienced in community care to develop the set of strategies.

The 10-item open-ended survey, used in the first round, was based on our qualitative study[16] that explored factors influencing adherence among stroke survivors using the Intervention Mapping approach,[38] which is underpinned by the Socio-Ecological Model.[39] Our framework is constructed on the Socio-Ecological Model of behavior change. Since there is limited access to healthcare facilities, higher cost of clinic-based rehabilitation, and lack of transport to hospital setup in low- and middle-income countries, home-based exercise adherence becomes crucial for recovery. Thus, the developed adherence strategies are applicable for low- and middle-income countries and could be influential for the success of home-based rehabilitation in the long term.

The suggested strategies were categorized into nine domains, which were in line with the findings in existing systematic reviews. [22, 40, 41, 42] The included studies reported behavior strategies and theories such as self-efficacy,[22] motivational interventions,[40] social-cognitive theory,[41] activity-monitoring, feedback system, goal-setting,[42] self-regulated exercises,[43] for improving adherence. However, none of the studies had used Delphi approaches and provided

broad concepts for enhancing exercise adherence without providing specific context, culture, or techniques for delivering the interventions.

Adherence is affected by multiple factors such as age, self-efficacy, caregiver support, previous exercise behavior, the severity of stroke, and stages of stroke recovery.[19,20,21,44,45] Therefore, the framework of strategies provides the opportunity to individualize the strategies based on each person's impairments, recovery, the severity of stroke, and available support system. The exercises can be tailored depending on the abilities and context of each person.

Adherence to post-stroke rehabilitation is a dynamic process and changes with each stage of recovery characterized by a rapid increase phase, slow decrease phase, and a stable phase.[46] Some strategies such as enhancing self-efficacy, activity scheduling, regular feedback, and monitoring can be initiated during the early phase while strategies such as interim progress tracking, personal graphs, involvement of peer group, gamification of exercises, providing rewards, and reminders can be started gradually to break the monotony of ongoing exercise programs and encourage adherence. Therefore, implementing these adherence strategies early in rehabilitation can be beneficial for maintaining adherent behavior in the long term. The results from a meta-analysis of mixed disease populations demonstrated that adherence is low when perceived disease severity is high among patients with serious illnesses.[47] However, future studies are needed to establish the effects of stroke severity on exercise adherence.

The different sets of strategies within the framework can be deployed to improve exercise adherence after stroke. The framework is useful for stroke survivors, caregivers, and healthcare providers as it offers adherence techniques at a personal, interpersonal, and organizational level. It gives clear recommendations on each strategy's content, different ways of delivering it, healthcare professionals who should design it, and on who might benefit from those strategies.

The uncertain strategies that were not agreed upon by the experts included participating in social events, regular checks by neighbors or games/competition with family/caregivers. Such strategies may improve the social interaction but may not be feasible due to the caregiver's burden after stroke,[48] and family members may not find adequate time for such activities. Other uncertain strategies such as virtual reality, circuit training, or award function were excluded due to the cost, training, and equipment required.[16] Strategies such as educating patients on the location and types of stroke and educational movies were considered redundant for improving exercise adherence.[49] Although social media such as Whatsapp was agreed upon by the experts as a mode of reminder, Whatsapp groups were not preferred as a strategy due to fear of dissemination of inaccurate information among the participants and compromising the privacy of health information.

The key strength of this study lies in the multidisciplinary nature of the expert panel that was recruited, which includes specialists in exercise prescription, experts in behavior, and community experts having diverse experiences that contributed to developing a multi-faceted framework of strategies. Most of the strategies are easy to implement, suitable for low-resource settings, affordable, and offer a comprehensive set for facilitating exercise adherence. We have tested these strategies in our recent randomized controlled trial and found it to be effective in improving adherence level among people with stroke.[50] Choosing the strategies from the framework can help in the pragmatic implementation in clinical practice or research trials. The framework is a useful guide for both clinicians and researchers to select appropriate strategies for enhancing exercise adherence.

We did not include stroke survivors and caregivers in the Delphi panel which we consider a limitation of this study. However, the perceptions of stroke survivors were explored to develop the questionnaire for the first round.[16] The representation of experts from each specialty was unequal which could have influenced the decision-making process that

differentiated certain versus uncertain strategies. Hence, some of the strategies deemed uncertain may have clinical relevance for supporting adherence. Moreover, as the open-ended questionnaire was developed from the literature review and opinions of stroke survivors in the previous study, the experts did not get a chance to develop the initial themes.

CONCLUSION

A set of strategies and a framework for enhancing adherence to home-based exercises after stroke has been developed and classified under nine domains: education on stroke and recovery, exercise prescription, feedback, and supervision, cognitive remediation, the involvement of family members, the involvement of society, promoting self-efficacy, motivational strategies, and reminder strategies. In countries where home-based exercises are the mainstay of rehabilitation, these strategies could reinforce self-management and facilitate adherence in the long term. Future studies should explore the experiences of stakeholders in implementing these strategies using qualitative methods. The set of strategies could be incorporated in a telerehabilitation model and cost-analysis could be performed in future.

Ethics statement

Institutional Ethics Committee, Kasturba Hospital, Manipal, India approved this study (IEC:355/2017)

Contributorship statement

The study was conceptualized by JMS and MN. AM, JMS, and MN developed the protocol and designed the methodology. AM contacted the experts and prepared the 10-item questionnaire. AD, DLM, GV, SP, STS, ArD, SDK, GN, HS, SKV, SK, BU and CE formed the expert panel and contributed in the development of the framework. AM analysed the data and prepared the first draft with supervision from JMS and MN. All authors have contributed in drafting and revising the manuscript.

Competing Interest

None declared

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Data sharing

No additional data available

References

1. Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. *J. stroke*. 2013;15:128–34.

2. 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. 2016.

3. Hankey G, MacLeod M, Gorelick P, et al. *Warlow's Stroke: Practical Management*. 4th ed. John Wiley & Sons Ltd.; 2019. Chapter 18: Rehabilitation after stroke: evidence, practice, and new directions; 867-877.

4. Pandian JD, Srikanth V, Read SJ, et al. Poverty and stroke in India: A time to act. *Stroke*. 2007;38:3063–9.

5. Craig LE, Wu O, Bernhardt J, et al. Approaches to economic evaluations of stroke rehabilitation. *Int. J. Stroke*. 2014;9:88–100.

6. Legg L. Rehabilitation therapy services for stroke patients living at home: systematic review of randomised trials. *Lancet*. 2004 [cited 2019 Jul 27];363:352–6.

7. Mayo NE. Stroke Rehabilitation at Home. *Stroke*. 2016;47:1685–91.

8. Susan Hillier, Inglis-jassiem G. Rehabilitation for community-dwelling people with stroke : home or centre based ? A systematic review. *Int. J. Stroke*. 2010;5:178–86.

9. Flynn A, Allen NE, Dennis S, et al. Home-based prescribed exercise improves balance-related activities in people with Parkinson' s disease and has benefits similar to centre-based exercise : a systematic review. *J. Physiother*. 2019; Available from: https://doi.org/10.1016/j.jphys.2019.08.003

10. Duncan PW, Horner RD, Reker DM, et al. Adherence to postacute rehabilitation guidelines is associated with functional recovery in stroke. *Stroke*. 2002;33:167–77.

11. Hubbard IJ, Harris D, Kilkenny MF, et al. Adherence to clinical guidelines improves patient outcomes in Australian audit of stroke rehabilitation practice. *Arch. Phys. Med. Rehabil*. 2012;93:965–71. Available from: http://dx.doi.org/10.1016/j.apmr.2012.01.011

12. Gunnes M, Indredavik B, Langhammer B, et al. Associations Between Adherence to the Physical Activity and Exercise Program Applied in the LAST Study and Functional Recovery After Stroke. *Arch. Phys. Med. Rehabil*. 2019. Available from: https://doi.org/10.1016/j.apmr.2019.04.023

13. Shaughnessy M, Resnick BM, Macko RF. Testing a Model of Post-Stroke Exercise Behavior. *Rehabil. Nurs*. 2006;31:15–21. Available from: https://doi.org/10.1002/j.2048-7940.2006.tb00005.x

14. Mahmood A, Solomon JM, English C, et al. Measurement of adherence to home-based exercises among community-dwelling stroke survivors in India. *Physiother. Res. Int.*; 2020 Apr;25(2):e1827. DOI: 10.1002/pri.1827.

15. Chen M, Rimmer JH. Effects of Exercise on Quality of Life in Stroke Survivors. *Stroke*. 2011;42(3):832-8372011.

16. Mahmood A, Nayak P, Kok G, et al. Factors influencing adherence to home-based exercises among community-dwelling stroke survivors in India : a qualitative study. *Eur. J. Physiother*.2019;0:1–7. Available from: https://doi.org/10.1080/21679169.2019.1635641

17. Damush, T.M., Plue, Laurie, Bakas, Tamilyn, et al. Barriers and Facilitators to

Exercise Among Stroke. *Rehabil. Nurs*. 1996;32:253–62.

18. Littlewood C, Mawson S, May S, et al. Understanding the barriers and enablers to implementation of a self-managed exercise intervention: A qualitative study. *Physiother*. (United Kingdom). 2015;101:279–85. Available from: http://dx.doi.org/10.1016/j.physio.2015.01.001

19. Clague-baker N, Carpenter C, Robinson T, et al. A qualitative study exploring patients', with mild to moderate stroke, and their carers' perceptions of healthy lifestyles. *Int J of Ther and Rehab*. 2017; September 2017, Vol 24, No. 9

20. Nicholson S, Sniehotta FF, Wijck F Van, et al. A systematic review of perceived barriers and motivators to physical activity after stroke. *Int. J. Stroke*. 2013;8:357–64. Available from: https://doi.org/10.1111/j.1747-4949.2012.00880.x

21. Sabate E. Adherence to long-term therapies: evidence for action. *World Health Organization*. 2003 [cited 14 September 2019].

22. Fryer CE, Luker JA, McDonnell MN, et al. Self management programmes for quality of life in people with stroke. *Cochrane Database Syst. Rev*. 2016; CD010442.

23. Jordan JL, Holden MA, Mason EE, et al. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Syst Rev*. 2010;2010(1):CD005956. Published 2010 Jan 20. doi:10.1002/14651858.CD005956.pub2.

24. Reunanen MAT, Jarvikoski A, Talvitie U, et al. Individualised home-based rehabilitation after stroke in eastern Finland--the client's perspective. *Health Soc. Care Community*. 2016;24:77–85.

25. Kok G, Gottlieb NH, Peters G-JY, et al. A Taxonomy of Behavior Change Methods; an Intervention Mapping Approach. *Health Psychol. Rev*. 2016;7199:1–32. Available from: http://dx.doi.org/10.1080/17437199.2015.1077155

26. Pill J. The Delphi method: Substance, context, a critique, and an annotated bibliography. *Socioecon. Plann. Sci*. 1971 [cited 2019 Aug 20];5:57–71.

27. Direito A, Walsh D, Hinbarji M, et al. Using the Intervention Mapping and Behavioral Intervention Technology Frameworks: Development of a mHealth Intervention for Physical Activity and Sedentary Behavior Change. *Heal. Educ. Behav*. 2017;1090198117742438. Available from: https://doi.org/10.1177/1090198117742438

28. Peek K, Carey M, Sanson-Fisher R, et al. Aiding patient adherence to physiotherapist-prescribed self-management strategies: an evidence-based behavioural model in practice. *Phys. Ther. Rev*. 2016;21:124–30. Available from: http://dx.doi.org/10.1080/10833196.2016.1226537

29. Kwasnicka D, Dombrowski SU, White M, et al. Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories. *Health Psychol. Rev*. 2016;10:277–96.

30. Picorelli AMA, Pereira LSM, Pereira DS, et al. Adherence to exercise programs for older people is influenced by program characteristics and personal factors: A systematic review. *J. Physiother*. 2014. DOI: 10.1016/j.jphys.2014.06.012

32. Meade LB, Bearne LM, Sweeney LH, et al. Behaviour change techniques associated with adherence to prescribed exercise in patients with persistent musculoskeletal pain: Systematic review. *Br. J. Health Psychol*. 2019;24:10–30.

33. DiMatteo MR, Haskard-Zolnierek KB, Martin LR. Improving patient adherence: a

three-factor model to guide practice. *Health Psychol. Rev.* 2012;6:74–91. Available from: http://www.tandfonline.com/doi/abs/10.1080/17437199.2010.537592

34. Picha KJ, Howell DM. A model to increase rehabilitation adherence to home exercise programmes in patients with varying levels of self-efficacy. *Musculoskeletal Care*. 2017;1–5.

35. Hsieh H-F, Shannon SE. Three Approaches to Qualitative Content Analysis. Qual. *Health Res.* 2005;15:1277–88. Available from: https://doi.org/10.1177/1049732305276687

36. Michie S, Stralen MM Van, West R. The behaviour change wheel : A new method for characterising and designing behaviour change interventions The behaviour change wheel : A new method for characterising and designing behaviour change interventions. *Implement. Sci*. 2011;6:42.

37. Jünger S, Payne SA, Brine J, et al. Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. *Palliat. Med*. 2017;31:684–706.

38. Bartholomew LK, Parcel GS, Kok G. Intervention Mapping: A Process for Developing Theory- and Evidence-Based Health Education Programs. *Heal. Educ. Behav*. 1998;25:545–63.

39. Kok G, Gottlieb NH, Commers M, et al. The Ecological Approach in Health Promotion Programs: A Decade Later. *Am. J. Heal. Promot*. 2008;22:437–41. Available from: https://doi.org/10.4278/ajhp.22.6.437

40. McGrane N, Galvin R, Cusack T, et al. Addition of motivational interventions to exercise and traditional Physiotherapy: A review and meta-analysis. *Physiother*.

(United Kingdom). 2015;101:1–12. Available from: http://dx.doi.org/10.1016/j.physio.2014.04.009

41. Meade LB, Bearne LM, Sweeney LH, et al. Behaviour change techniques associated with adherence to prescribed exercise in patients with persistent musculoskeletal pain: Systematic review. *Br J Health Psychol*. 2019;24(1):10-30. doi:10.1111/bjhp.12324.

42. Peek K, Sanson-Fisher R, Mackenzie L, et al. Interventions to aid patient adherence to physiotherapist prescribed self-management strategies: A systematic review. *Physiother*. (United Kingdom). 2016;102:127–35. Available from: http://dx.doi.org/10.1016/j.physio.2015.10.003

43. Oesch P, Kool J, Fernandez-Luque L, et al. Exergames versus self-regulated exercises with instruction leaflets to improve adherence during geriatric rehabilitation: a randomized controlled trial. *BMC Geriatr*. 2017;17:77.

44. Okezue OC, Nwafor GC, Ezeukwu OA, et al. Adherence to Home Exercise Programmes and its Associated Factors among Patients Receiving Physiotherapy. *Clin. Heal. Promot*. 2019;9:7–14.

45. Eynon, Michael, Foad, Jessica, Downey, John, et al. Assessing the psychosocial factors associated with adherence to exercise referral schemes : A systematic review. *Scand. J. Med. Sci. Sport*. 2019;1–13.

46. Chen J, Tan X. Defining the rehabilitation adherence curve and adherence phases of stroke patients : an observational study. *Patient Prefer. Adherence*. 2017;11:1435–41.

47. Dimatteo MR, Haskard KB, Williams SL. Health Beliefs, Disease Severity, and Patient Adherence: A Meta-Analysis. *Med. Care.* 2007;45:521–8.

48. Jaracz K, Grabowska-Fudala B, Kozubski W. Caregiver burden after stroke: towards a structural model. *Neurol. Neurochir. Pol*. 2012;46:224–32.

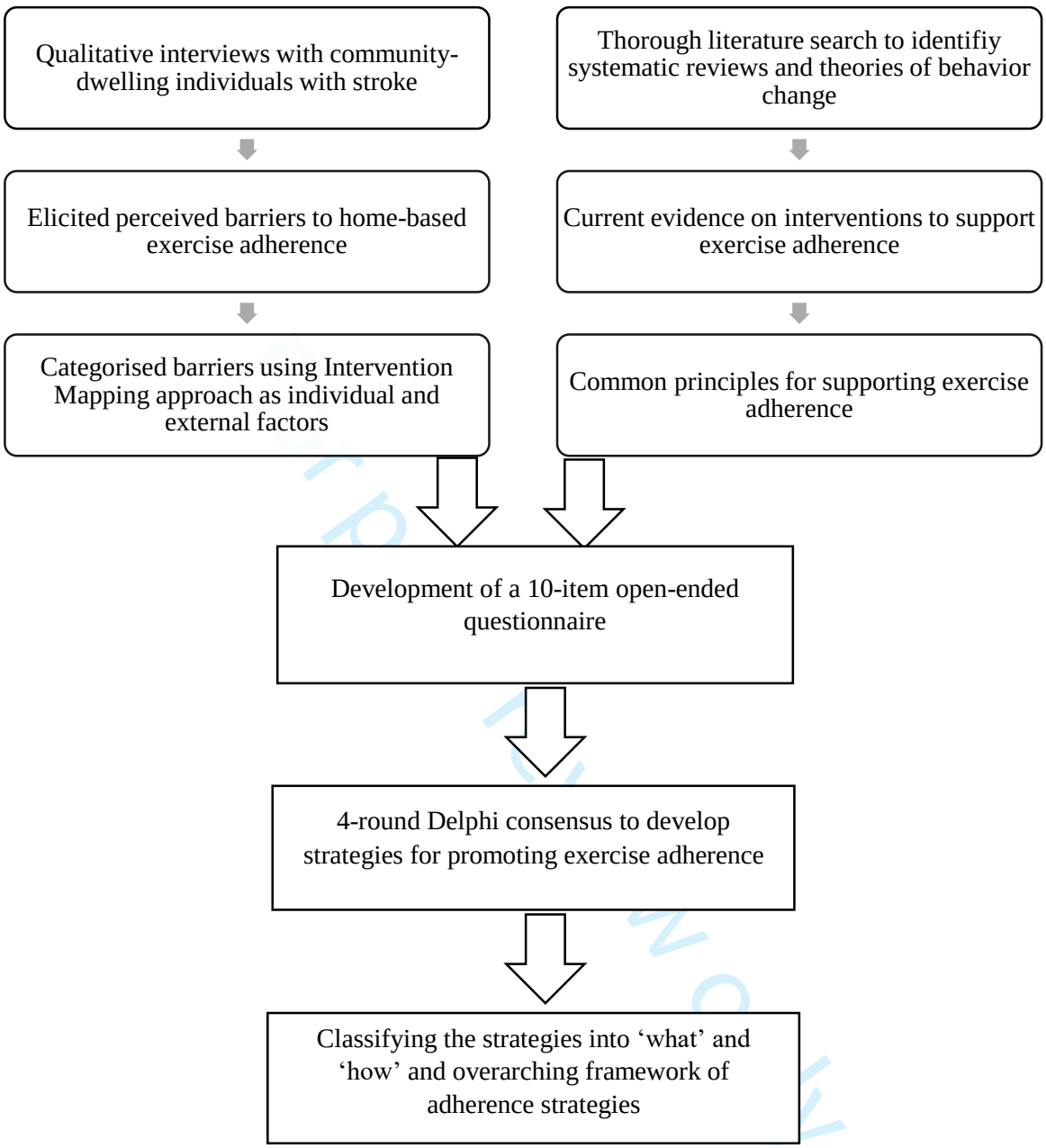
49. Kamalakannan S, Gudlavalleti Venkata M, Prost A, et al. Rehabilitation Needs of Stroke Survivors After Discharge From Hospital in India. *Arch. Phys. Med. Rehabil*. 2016;97:1526-1532.e9. Available from: http://dx.doi.org/10.1016/j.apmr.2016.02.008

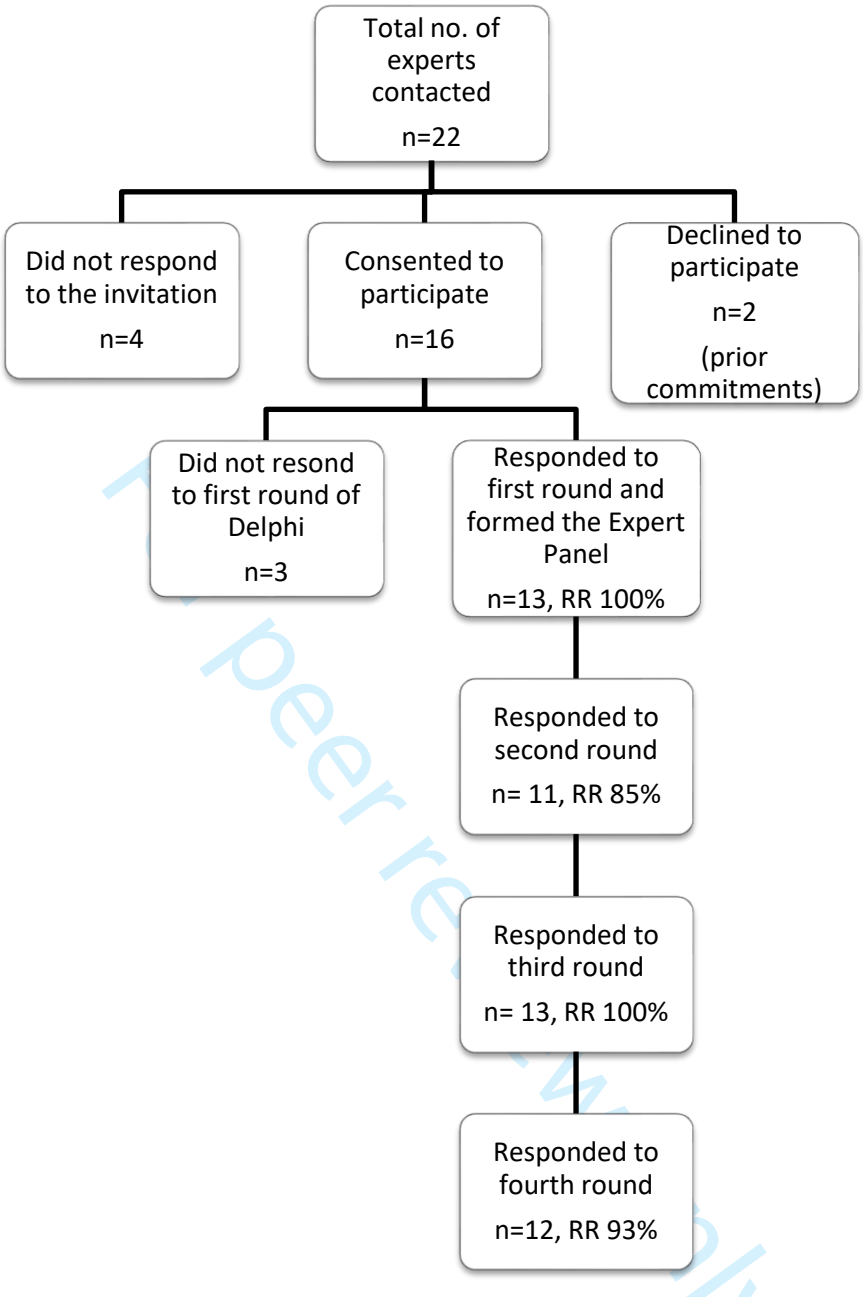
50. Mahmood A, Nayak P, English C, et al. Adherence to home exercises and rehabilitation (ADHERE) after stroke in low-to-middle-income countries: A randomized controlled trial. *Top Stroke Rehabil*. 2021 Jun 28:1-11. doi: 10.1080/10749357.2021.1940800.

Figure Legend

Figure 1: Process of development of adherence framework

Figure 2: Flow of participants and response rate in each round


Qualitative interviews with community-dwelling individuals with stroke
Thorough literature search to identifiy systematic reviews and theories of behavior change
Elicited perceived barriers to home-based exercise adherence
Current evidence on interventions to support exercise adherence
Categorised barriers using Intervention Mapping approach as individual and external factors
Common principles for supporting exercise adherence
Development of a 10-item open-ended questionnaire
4-round Delphi consensus to develop strategies for promoting exercise adherence
Classifying the strategies into ‘what’ and ‘how’ and overarching framework of adherence strategies



***RR, Response rate**

Supplementary file 1: Open-ended questionnaire and summary of responses obtained in Round 1

Q1. Please list the contents that should be included in the patient education about stroke recovery. Suggest a few approaches that could be used for education? Answers*:* Educating about stroke, its usual course of recovery, do's and don'ts, benefits of exercises, complications of stroke and its management, and role of caregiver.
Q2. Please suggest ways for exercise prescription? Answers*:* Prescription of exercises in the form of videos, written instructions, pictures along with demonstration and practice. Prescribing few individualized exercises which are fun and engaging.
Q3. Please suggest ways for taking regular feedback from a patient and clearing any doubts during exercises? Answers: Regular contact with therapists, use of apps or mHealth, monitoring exercises, daily log, and charting of activities.
Q4. Please suggest a way of cognitive remediation for facilitating adherence? Answers: Use of Cognitive Behavior Therapy techniques, motivational interviewing, and counselling. Positive reinforcement and importance to micro gains.
Q5. Please suggest on how family members can help to facilitate adherence? Answers: Emotional support, encouragement, being exercise buddies, setting up reminders, and preventing complications.
Q6. Please suggest ways on how friends, neighbor, colleagues, others can be involved to encourage exercise? Answers*:* Frequent interaction with friends and colleagues, group therapy, association of families, comparison with others.
Q7. Please suggest ways to train the patients to self-monitor & continue exercising and solve problems related to exercise adherence? Answers*:* Monitoring exercises, personal graphs, activity scheduling, promoting self-efficacy, and problem-solving, provide ongoing support.
Q8. Please provide ways for motivating patients to adhere to interventions? Answers*:* Showing improvement and progress, standard and interim assessments, positive feedback mechanisms, telephonic follow up, positive log, and track of consultations.
Q9. Please suggest ways for providing reminders to exercises? Answers*:* Regular follow up, tally sheets, reminders, apps, daily logs, pamphlets, cues and prompts.
Q10. Please suggest features of a web-app/mhealth intervention to facilitate adherence?

Answers*:* Tracking and real-time feedback, activity mapping, virtual games, daily reminders, personalized information, interactive community, progress report, and appreciation.

Supplementary file 2: Level of agreement between experts on uncertain strategies in Round 2

S. No	Unsure strategies	Agreeing experts, n (%) (N=11)	Strategy included for the next round
1.	Activity log/scheduling	8 (73)	Included
2.	Award function every two months	3 (27)	Excluded
3.	Certain use of aids may help them for better balance and self-efficacy	4 (36)	Excluded
4.	Circuit training	1 (9)	Excluded
5.	Coaching methodology	7 (64)	Included
6.	Competition for caregivers and family	2 (18)	Excluded
7.	Contingency charts /plan	9 (82)	Included
8.	Devise color bands coded for level of recovery and mastery of tasks	7 (64)	Included
9.	Information on stroke type and location	4 (36)	Excluded
10.	Home movies for family viewing	4 (36)	Excluded
11.	Individualized program	9 (82)	Included
12.	Involving group sessions	7 (64)	Included
13.	mHealth	7 (64)	Included
14.	Participation in social events	4 (36)	Excluded
15.	Peer support/exercise buddies	8 (73)	Included
16.	Pie chart for social and emotional impact on the patients	3 (27)	Excluded
17.	Posters in the waiting area	7 (64)	Included
18.	Provide tokens and badges for improvement	8 (73)	Included
19.	Psychoeducation	9 (82)	Included
20.	Regular check by neighbors	1 (9)	Excluded
21.	Rotate family members in caregiving	8 (73)	Included
22.	Task-oriented therapy	8 (73)	Included
23.	Virtual reality	4 (36)	Excluded
24.	Wall of fame/display board	7 (64)	Included
25.	Whatsapp group	4 (36)	Excluded

Supplementary file 3: Framework of strategies for facilitating home-based exercise adherence post stroke

S.no	Domain	Strategies	Healthcare provider	Stakeholder
1	**Education about stroke and recovery**	• Education on usual time course and speed of recovery after stroke • Impact of practice and exercise on recovery • Negative effects of rest and positive effects of activity on stroke recovery • Importance of secondary risks management • Managing complications (e.g., spasticity, pain, fatigue, contracture, depression and cognitive changes) • Awareness on interventions without evidence (including traditional medicines and religious practices) • Importance of adhering to the exercise program • Dosage of the exercise program • Information about expected outcomes based on severity • Proper positioning techniques • Misconceptions about stroke recovery • Role of a caregiver Education can be delivered via written information, group sessions, individual discussions, testimonials from recovered patients and caregivers, phone calls	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient, Caregiver
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**

2	**Exercise prescription**	• Relevant exercises for each persons' goals and context • Individually-tailored exercises • Contingency plan and including enough opportunities for independent and autonomous activities • Personalized information/messages on the exercise prescription • Fun and engaging such as gaming or gamification • Use of voice-assisted programs or web-app • Prioritizing and focusing on only a few activities at a time • Demonstration and practice of the prescribed exercises • Written and pictorial instructions (avoid using too many colors and keep it simple and clean) • Videos of exercises • Simple written handout - no more than one printed page • Using a minimum of two and maximum of three mediums (various sensory modalities) when prescribing information • Online tracking application (feed-in everyday progress) • Video recording of patients' exercise performance • Splitting the exercise into smaller and easier steps, and gradually increasing in difficulty	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**

3	**Feedback and supervision**	• Maintaining an exercise log • Daily monitoring of health status and updates of patients by the medical team • Exercise charts - with pictures of each step and a simple breakdown of the activities • Clearing doubts • Obtaining information on progress from patients and caregivers and their experience/quality of care/interaction • Evaluate frequency, form, intensity, and duration of exercise • Maintaining some form of regular contact with therapists - in person or via telehealth • Online web applications that can be accessed by the patients, caregivers, and medical team for recording everyday health status • Recorded audio/video clips to guide the exercise session • Individual and group discussion • Internal feedback • Providing verbal/manual cues at salient points during the exercise, and asking the person what went right and what could be improved • Standardized assessment using clinical outcome measures	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
4	**Cognitive remediation**	• Prescribing functional tasks and planning the exercises focusing on patients' goals • Understanding the exercise behavior of the patient before the treatment session • Educating the patients and caregivers about the benefits of performing exercises • Incorporating a schedule, involving group sessions, and relevant tasks • Positive feedback, reinforcement, and giving importance to micro gains • Assessing intention to exercises- use of Motivation Enhancement Therapy or motivational interviewing • Contingency charts and behavioral activation	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient, caregiver

	Domain	Strategies	Healthcare provider	Stakeholder
5	**Involvement of the family members**	• The family must be involved for a limited amount since it encourages dependency • Management of expressed emotions of the family members that may hinder treatment and restrict the autonomy of the patient • Evaluating caregivers' burden and having frequent sessions to reduce the burnout and to encourage their efforts towards the patient • Assessing knowledge and understanding of the caregivers on the importance of post-stroke exercises • Family can provide emotional support and encouragement • Exercise buddies • Setting up reminders on the patients' phone for anchor points of the day (daily routines/meals/exercise/leisure activities/family time/planned activities) • Developing, demonstrating, and practicing activities with family • Reinforcing adaptive behaviors • Assisting in exercises and preventing complications • Designing a few exercises that involve family members • Rotation of family members for caregiving roles (reduces burnout, improves support, and maintains novelty) • Tracking the progress and delivering rewards to the patient - tangible/intangible	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Caregiver
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
6	**Involvement of society**	• Interaction with colleagues on topics not concerning the illness (preferably the patient's work/politics/current affairs/sports) • Weekly scheduled interactions (phone/face-to-face) with friends, neighbors or colleagues • Creating an association of families caring for stroke or support group	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke	Community

		• Testimonials of recovered patients and their experiences about rehabilitation • Awareness programs for healthy adults • Group exercise for stroke survivors in that particular locality • Peer support or exercise buddies	nurse)	
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
7	**Promoting self-efficacy**	• Use of evidence-based behavior change strategies (e.g., the Capacity Opportunity Motivation-Behavior model, or Intervention Mapping or Coaching Methodology) • Using substitution and optimization principles • Working out with patients on what monitoring will be best for them - exercise practice sheet, paper diary, electronic diary, app • Providing ongoing support once the therapy program has ended • Personal graph chart of success that can be generated weekly or monthly • Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision and support from the caregivers • Setting reminders on the phone or alarms on the clock; identifying anchors in the day (sleep times/meals/activities - exercise, recreation, social) • Setting a general intention of sticking to their exercise program with more specific goals (i.e., intention and "if/then" plans) • Patients could be advised to think of barriers that would impede their exercise sessions, and list ways of overcoming such barriers • Use of pie-charts/pros-con analysis/identification of cognitive distortions/downward arrow techniques for problem analysis and developing a life brochure and art-based therapeutic activities for promoting self-efficacy	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient

	Domain	Strategies	Healthcare provider	Stakeholder
8	**Motivational strategies**	• Tracking and reporting exercise adherence • Showing functional improvement • Measuring performance-repetitions, duration of exercise, exercise intensity, or distance walked • Positive feedback mechanisms at home with the help of caregivers to reward adherence and home activities • Importance to micro gains • Reminding positive experiences with exercise before a stroke • Measuring functional improvements using clinical measures that can help patients appreciate improvements in their health • Telehealth, self-monitoring, diaries • Devise individual graphs (every three sessions plus monthly) • Have a display board/wall of fame where "patient of the month" and photos of patients achieving good outcomes is displayed online or in clinical setup • Telephonic follow-up where the medical team provides words of encouragement • Productivity monitor that has to be filled out by the patient to code the level of functioning for every day in various domains • Maintaining a positive log (paper-pencil or online) two events each day gave the patient a reason to be happy • Feedback at regular intervals using objective outcomes • Setting progressive but achievable targets and involving patients in goal setting • Devising color bands (coded for level of recovery and mastery of tasks). Reinforcing the patients by providing t-shirts or color bands of a particular color that represents certain level of recovery or mastery of task. Upgradation of color bands with progression of tasks.	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient

		• Conducting intra-group competitions for patients (within a given color band) during group sessions • Providing tokens and badges for improvement - which can be exchanged for tangible rewards • Interactive community - can add friends to motivate each other using web app or in community centers		
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
9	**Reminder strategies**	• Calling them on a regular basis and visiting them weekly or fortnightly • Tally sheet, mobile applications, pamphlets, SMS reminders or WhatsApp reminders • Using videos to show exercise steps and giving the same material for home practice • Auditory - use voice recording during the exercise session so that the patient can use the same tapes at home during practice • Alarms/music clips to indicate the time to switch between exercises • Technology - sending small surveys about feedback, information, some scientific literature, and progress card • Daily logs - either electronic or paper-pencil to track mood, exercise, food intake, sleep, social engagement, and grooming activities • Audio – alarms to orient patient to engage in tasks and taking medications. • Weekly reviewing the exercise log • Cues/prompts such as sticky notes in the patients' homes • Follow-up phone calls from the health care professionals • Visible wall posters on exercises	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient, caregiver

Standards for Reporting Qualitative Research (SRQR)*

http://www.equator-network.org/reporting-guidelines/srqr/

	Page/line no(s).
Title and abstract	
Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	1/1-2
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	1/ 4-22
Introduction	
Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	3-4/48-76
Purpose or research question - Purpose of the study and specific objectives or questions	4/79-81
Methods	
Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	5/101-103
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	5/107-109
Context - Setting/site and salient contextual factors; rationale**	NA
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	5/93-99
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	4/85-86
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	5/100-107

Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	6/125-129
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	8/168-169
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	6/128-129
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	6/129-132
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	7/149-151

Results/findings

Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	10-21/179-342
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	Supplementary file 1

Discussion

Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	21-23/350-408
Limitations - Trustworthiness and limitations of findings	23-24/409-416

Other

Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	None
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	None

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Reference:

O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. **Standards for reporting qualitative research: a synthesis of recommendations.** *Academic Medicine*, Vol. 89, No. 9 / Sept 2014
DOI: 10.1097/ACM.0000000000000388

BMJ Open

Development of strategies to support home-based exercise adherence after stroke in Low- and Middle-income Countries: A Delphi Consensus

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-055946.R1
Article Type:	Original research
Date Submitted by the Author:	13-Nov-2021
Complete List of Authors:	Mahmood, Amreen; Manipal Academy of Higher Education, Physiotherapy; KMC Mangalore, Physiotherapy Deshmukh, Anagha; Manipal College of Health Professions, Clinical Psychology Natarajan, Manikandan ; Manipal College of Allied Health Sciences, Physiotherapy Marsden, Dianne ; Hunter New England Local Health District Vyslysel, Glade; Hunter New England Local Health District Padickaparambil, Sebastian; Manipal College of Allied Health Sciences, Department of Psychology TS, Shwetha; Manipal Academy of Higher Education, Department of Clinical Psychology Direito, Artur; University College London, Health Psychology Kumaran, Senthil ; Manipal College of Health Professions, Physiotherapy N, Girish; Manipal College of Health Professions, Physiotherapy Sachdev, Harpreet ; All India Institute of Medical Sciences, Neurology Kumar Veluswamy, Sundar; MS Ramaiah Medical College Karthikbabu, Suruliraj ; Manipal College of Health Professions Unnikrishnan, B.; Kasturba Medical College Mangalore, Community Medicine English, Coralie; University of Newcastle, School of Health Sciences Solomon, John; Manipal College of Allied Health Sciences, Physiotherapy
Primary Subject Heading:	Neurology
Secondary Subject Heading:	Qualitative research, Health services research, Patient-centred medicine, Sports and exercise medicine, Neurology
Keywords:	Stroke < NEUROLOGY, Rehabilitation medicine < INTERNAL MEDICINE, Stroke medicine < INTERNAL MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Development of strategies to support home-based exercise adherence after stroke in Low- and Middle-income Countries: A Delphi Consensus

A. Author and co-authors' name

Amreen Mahmood, Anagha Deshmukh, Manikandan Natarajan, Dianne Lesley Marsden, Glade Vyslysel, Sebastian Padickaparambil, Shwetha Tumkur Shivakumar, Artur Direito, Senthil D. Kumaran, Girish Nandakumar, Harpreet Sachdev, Sundar Kumar Veluswamy, Suruliraj Karthikbabu, Bhaskaran Unnikrishnan, Coralie English, John M. Solomon

B. Corresponding Author Details

Dr. John Solomon M,
Coordinator, Centre for Comprehensive Stroke Rehabilitation and Research,
Head & Associate Professor, Department of Physiotherapy,
Manipal College of Health Professions,
Manipal Academy of Higher Education, Manipal, Karnataka, India
Mail id: john.solomon@manipal.edu

Phone no: +919945670671

Permanent address: Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka, India. Pin code: 576104

C. The full names, institutions, city, and country of all co-authors

1. **Amreen Mahmood**, 1-Department of Physiotherapy, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India. 2 - Department of

Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

2. **Anagha Deshmukh**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

3. **Manikandan Natarajan**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

4. **Dianne Lesley Marsden**, 1-Hunter Stroke Service, Hunter New England Local Health District, New Lambton Heights, NSW, Australia. 2-Priority Research Centre Stroke and Brain Injury, University of Newcastle, Callaghan, NSW, Australia. 3-Brain and Mental Health Program, Hunter Medical Research Institute, New Lambton Heights, NSW, Australia. 4-Centre of Research Excellence in Stroke Rehabilitation and Brain Recovery, Newcastle and Melbourne, Australia.

5. **Glade Vyslysel**, Westlakes Community Rehabilitation Team, Hunter New England Local Health District, NSW, Australia

6. **Sebastian Padickaparambil**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

7. **Shwetha Tumkur Shivakumar**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

8. **Artur Direito**, 1-UCL Centre for Behaviour Change, University College London, London, UK. 2-Yong Loo Lin School of Medicine, National University of Singapore, Singapore.

9. **Senthil D. Kumaran**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

10. **Girish Nandakumar**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

11. **Harpreet Sachdev**, Department of Neurology, All India Institute of Medical Sciences, New Delhi, India.

12. **Sundar Kumar Veluswamy,** Department of Physiotherapy, Ramaiah Medical College, Bengaluru, India.

13. **Suruliraj Karthikbabu,** Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Bengaluru, India.

14. **Bhaskaran Unnikrishnan,** Department of Community Medicine, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India.

15. **Coralie English**, School of Health Sciences and Priority Research, Centre for Stroke and Brain Injury, University of Newcastle, Newcastle, Australia.

16. **John M. Solomon**, 1- Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India. 2 - Centre for Comprehensive Stroke Rehabilitation and Research, Manipal Academy of Higher Education, Manipal, India.

D. Keywords

Developing Countries; Home-based exercises; Patient-Centered care; Patient Compliance; Stroke rehabilitation

E. Word count (excluding title page, references, figures)

3824

Abstract

Objective: To develop a set of strategies to enhance adherence to home-based exercises after stroke, and an overarching framework to classify these strategies.

Method: We conducted a four-round Delphi consensus (two online surveys, followed by a focus group then a consensus round). The Delphi panel consisted of 13 experts from Physiotherapy, Occupational Therapy, Clinical Psychology, Behavior Science, and Community Medicine. The experts were from India, Australia, and United Kingdom.

Results: In round 1, a 10-item survey using open-ended questions was emailed to panel members and 75 strategies were generated. Of these, 25 strategies were included in round 2 for further consideration. A total of 64 strategies were finally included in the subsequent rounds. In round 3, the strategies were categorized into nine domains – i) patient education on stroke and recovery, ii) method of exercise prescription, iii) feedback and supervision, iv) cognitive remediation, v) involvement of family members, vi) involvement of society, vii) promoting self-efficacy, viii) motivational strategies and ix) reminder strategies. The consensus from 12 experts (93%) led to the development of the framework in round 4.

Conclusion: We developed a framework of comprehensive strategies to assist clinicians in supporting exercise adherence among stroke survivors. It provides practical methods that can be deployed in both research and clinical practices. Future studies should explore stakeholders' experiences and the cost effectiveness of implementing these strategies.

Strengths and limitations of this study

- The multidisciplinary expert panel consisted of specialists in exercise prescription, behavior science and community medicine, each having diverse experiences that contributed to the development of this multi-faceted framework of strategies
- We developed strategies specific to low- and middle- income countries that are affordable and provide practical methods of implementation
- One of the limitations of this study was that the individuals with stroke and their caregivers were not included in the Delphi panel
- There was an unequal representation of experts from different specialties

INTRODUCTION

Stroke is one of the leading causes of death and disability in India.[1] Rehabilitation is recommended to promote recovery, enhance independence, and improve quality of life after a stroke.[2,3] However, healthcare services, and comprehensive stroke rehabilitation centers are often expensive and beyond people's reach.[4,5] Considering the limited access to hospital-based healthcare services after stroke,[4] home-based rehabilitation is often preferred, and sometimes the only option for stroke survivors living in low resource settings.[6,7] Home-based rehabilitation has been shown to have functional and cost benefits.[8,9] Adherence to the home-based regimen is of utmost importance for any intervention to be beneficial.[10,11] Improving adherence to exercise program after stroke has been shown to improve functional recovery. [12]

Non-adherence to physical exercises is a common problem among stroke survivors.[13] The level of adherence to prescribed home-based exercises among Indian stroke survivors was found to be only 28%.[14] Barriers to exercise after stroke include factors at the individual, interpersonal, organizational, and community levels.[15,16] Modifiable factors include lack of knowledge about stroke, lack of supervision and motivation, and inadequate exercise prescription by healthcare providers.[16,17,18] Other factors that impact adherence include pain, fear of falls, and post-stroke fatigue.[19,20] In addition, environmental factors such as cost, accessibility, and transport are other barriers for people with chronic stroke. Thus, developing effective strategies that reinforce adherence to home-based exercises is important.[20] As stated by the World Health Organization, "increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments."[21] Therefore, improving adherence to post-stroke rehabilitation can enhance recovery and improve the quality of life among stroke survivors.[22]

Exercise adherence can be improved through motivational interventions, behavioral change strategies, multimedia, follow-up sessions, feedback, cognitive behavior therapy, skill training, self-monitoring, goal setting, coping strategies, and coaching.[22,23,24] However, there is limited information on how to practically incorporate these into clinical practice. Therefore, developing strategies for promoting post stroke exercise adherence is essential.[12,15] Identifying barriers affecting adherence to exercise, and developing strategies that can be practically implemented by stroke survivors to modify those barriers, increases the potential for improving exercise adherence.[25] Thus, we aimed to develop a set of strategies to facilitate adherence to home-based exercises after stroke and a comprehensive framework to classify these strategies.

METHODS

We obtained approvals from the Institutional Research Committee and Institutional Ethics Committee (IEC:355/2017) of Kasturba Hospital, Manipal, India to conduct this study. This study was a part of a doctoral thesis which was conducted in four phases. In the first phase we measured level of exercise adherence among community living stroke survivors. In the second phase, we conducted qualitative interviews with stroke survivors to understand the factors affecting exercise adherence. Based on the themes developed during qualitative study, we prepared a survey for use in this third phase which is a Delphi study. The fourth phase involved testing the effectiveness of developed framework of strategies in a pilot RCT.

Participant recruitment

Participants (experts) were recruited using purposive sampling. The criteria for selection were: i) expertise in stroke/ behavior change/ community health, ii) having more than ten years of clinical experience, iii) published in peer-reviewed journals, iv) involvement in translational and collaborative health research and v) employed in academia, research or clinical practice.

We identified the experts through the collaborative network of the Centre for Comprehensive Stroke Rehabilitation and Research at the Manipal Academy of Higher Education. We aimed to recruit the majority of experts from India to ensure suggestions were context-specific to low- and middle-income countries. We invited experts to participate in the study from different fields (Physiotherapy, Occupational Therapy, Neurology, Clinical Psychology, Community Medicine, and Behavior Science) to ensure that the strategies were comprehensive and covered multiple aspects of adherence.

Experts were invited via email. Those who agreed to participate gave their written consent and were included in the study. We conducted a four-round Delphi consensus; two online surveys, followed by a focus group to build a set of adherence strategies for home-based exercises based on survey results, then a final online consensus round.[26] Each round took two months. Experts were sent two reminder emails and any non-respondents were excluded from that round. Except for the focus group, the experts were blinded to each other for all rounds, and responses were anonymous. The Delphi rounds were conducted between January 2018 and December 2018. The primary investigator, an experienced stroke physiotherapist (AM) collected and analyzed the data. The focus group was conducted by another investigator (JS) who has more than 15 years of experience in neurological rehabilitation and qualitative studies.

Data collection and analysis

Round 1

Our previous study explored factors influencing adherence to home-based exercises among stroke survivors through in-depth interviews.[16] Using this information, we categorized the barriers reported by the stroke survivors into internal and external factors using the Intervention Mapping approach.[25] We also performed a literature search in PubMed, Scopus, Web of Science, and Cochrane using the search terms "physical exercises," "adherence," "compliance," "behavior change," and "health behavior." We reviewed studies from the bibliographies of the relevant articles. We identified health behavior change theories and existing strategies/interventions used for improving adherence to long-term therapies. Our review of the literature identified common principles for supporting adherence such as motivation, self-efficacy, social support, the role of family, online health support (mHealth), and behavior change techniques.[27,28,29,30,31,32,33,34] Our findings from the literature and our qualitative study were combined to form a 10-item survey using open-ended questions in SurveyMonkey software (https://www.surveymonkey.com/). The survey was then emailed to the expert panel (Supplementary file 1).

We merged the experts' written responses to perform content analysis[35] and coded the responses using Atlas.Ti8 software. The responses that were suggested by more than nine out of 13 (70%) experts were considered as 'certain strategies.' Responses that were not common and suggested by less than nine experts were labeled 'uncertain strategies' for further consideration in round 2.

Round 2

The second survey, consisting of only the 'uncertain strategies', was emailed to the expert panel, and they were asked to agree/disagree on the given strategies, and provide reasons for their opinion. For an 'uncertain strategy' to become a 'certain strategy" it needed to have a majority agreement, i.e., six out of 11 experts. This process resulted in a final set of 64 strategies.

Round 3

We then conducted a face-to-face focus group to collate the included strategies into broader categories. The expert panel was asked to categorize the list of strategies into a specific domain. They also suggested practical ways of implementing the suggested strategies such as: who should design it, the content, how it should be delivered, and target stakeholders. Any experts who could not be present at the focus group were emailed the categories and asked to evaluate the draft framework.

Round 4

The framework of strategies was sent to all the experts for minor modifications and approval. The consensus from the experts led to the development of the final framework. Figure 1 shows the development of the framework.

Patient and Public Involvement

The aim of the study was to provide guidance to facilitate adherence to home exercise programs. As a first step, it was felt important to understand patient experiences in exercise

adherence. Towards this end, qualitative interviews were conducted among community-dwelling stroke survivors to explore their exercise behavior and barriers to exercise adherence in the second phase of this project. The patients' opinions highlighted that not only patient-related factors but family, healthcare system, and community level factors played a role in exercise non-adherence. This information was used in the development of open-ended questions that were included in the first round of the Delphi process. Therefore, the patients' perceptions and needs were incorporated in this study for designing adherence strategies and framework.

RESULTS

We invited 22 experts across India and abroad to participate in the Delphi survey. Thirteen consented to participate in the study and responded to round one (Figure 2). The final panel consisted of physiotherapists (n=7), clinical psychologists (n=3), occupational therapist (n=1), behavior scientist (n=1), and epidemiologist (n=1). Three experts were from Australia, one from the UK, and the remaining experts were from India. Each panel member had more than ten years of clinical experience and multiple publications. (Table 1)

Table 1: Details of participants

Participants	Qualification	Area of work	Expertise	Country
1	Epidemiologist	Research, Academic	Community and rural health Associated with the World Health Organization, Indian Council of Medical Research, and Global Burden of Disease Network	India
2	Occupational Therapist	Clinical	Stroke care and activities of daily living	Australia
3	Physiotherapist	Research, Academic	Stroke rehabilitation and physical activity. Associated with the World Stroke Organization, Stroke Recovery and Rehabilitation Roundtable, and Priority Research Centre for Stroke and Brain Injury	Australia
4	Physiotherapist	Research	Stroke and cardiorespiratory fitness. Associated with the World Stroke Organization and Priority Research Centre for Stroke and Brain Injury	Australia
5	Physiotherapist	Clinical	Stroke rehabilitation	India
6	Physiotherapist	Research, Academic	Stroke rehabilitation	India
7	Physiotherapist	Research, Academic	Community Physiotherapy, and technology in rehabilitation	India
8	Physiotherapist	Research, Academic, Clinical	Physical activity epidemiology	India
9	Physiotherapist	Research, Academic, Clinical	Stroke rehabilitation	India
10	Behavior scientist	Research	Behavior change evidence and theories. Designing and evaluation of behavior change interventions	UK
11	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India
12	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India
13	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India

Round 1

The open-ended survey and the summary of responses received in the first round are provided in supplementary file 1. The content analysis of the responses received in round one yielded a total of 75 strategies. Of these, 50 strategies were suggested by more than nine experts (i.e., >70%) and were considered 'certain.' The remaining 25 were considered 'uncertain' strategies (suggested by less than nine experts) and were included in the next round for further consideration.

Round 2

The response rate for round two was 85% (11 experts.) Frequency analysis yielded 14 uncertain strategies that were agreed upon by most experts (>50%). The remaining 11 strategies were excluded. The percentage of agreement for each uncertain strategy is provided in supplementary file 2. We included a total of 64 strategies (50+14) for the subsequent rounds.

Round 3

Six experts (three clinical psychologists, two physiotherapists, and one epidemiologist) participated in the face-to-face focus group. The remaining seven experts responded via email and provided input to the framework. The final 64 strategies were grouped into nine domains (Table 2).

Table 2: Grouping of strategies into specific domains

Items	Domains	Strategies
1	**Patient education on stroke and recovery**	• Patient education about stroke and its treatment • Patient education on adherence • Caregiver education and involvement • Written instructions & pictures • Testimonials from recovered patients • Information on support agencies • Benefits of exercise • Psychoeducation
2	**Exercise prescription**	• Written instructions & pictures • Videos of exercises • Task-oriented training • Prioritizing on a few tasks at a time • Meaningful and relevant exercises • Breaking down exercises into smaller steps • Individualized program • Fun and engaging exercises • mHealth apps • Demonstrate and practice exercises
3	**Feedback and supervision**	• mHealth apps • Activity log • Feedback from patients • Feedback on their progress • Exercise charts with video/audio recording • Asking to tell approach • Clearing doubts by the medical team • Regular contact with therapists • Recording exercises for feedback

		• Regular monitoring • Understand previous exposure with exercises
4	**Cognitive remediation**	• Educating on the benefits of exercise • Motivational interviewing • Cognitive Behavior Therapy techniques • Behavioral activation • Contingency charts • Involving group sessions • Meaningful tasks • Psycho education

5	**Involvement of family members**	• Exercise buddies • Emotional support • Assessing knowledge and understanding of the family on the importance of exercise • Rotate family members in care giving • Activity scheduling
6	**Involvement of society**	• Involvement of friends • Involving group sessions • Modeling behavior • Support and exercise groups • Social comparison
7	**Promoting self-efficacy**	• Personal graph charts • Reduce the number of alternatives presented to the patient • Provide activities that can be done independently • Standardized assessment • Goal setting • Self-efficacy enhancement: using substitution and optimization principles • Ongoing support • Methods of tracking exercises • Coaching methodology • Psycho education
8	**Motivational strategies**	• Patient's videos to show improvement • M-Health (any form of monitoring, consultation, assessment, or therapy delivered using mobile devices) • Interim assessments • Feedback on progress – importance to micro gains • Positive log diary • Wall of fame/display board • Provide tokens and badges for improvement • Methods of education & counseling

		• Devise color bands (coded for level of recovery) • Intra-group competition • Avoid direct comparison
9	**Reminders strategies**	• Reminder phone calls • Use of media • Sticky notes • Alarms/music clips • Auditory - use voice recording during therapy sessions • Logbook • Posters in the waiting area for hospital settings • Whatsapp (or similar) for reminder

Round 4

The final framework of strategies for improving home-based exercise adherence was agreed upon by 12 (93% response rate) experts. The experts agreed that the exercise-related strategies should be designed and delivered by therapists having experience in stroke care such as an occupational therapist, physiotherapist, physiatrist, or stroke nurse. They suggested that the strategies requiring behavioral techniques should be designed and supervised by a licensed clinical psychologist or behavior therapist. In the following section, we have highlighted the key suggestions from the expert committee under each domain. The details of the framework are provided in supplementary file 3.

Strategies for improving adherence to home-based exercises post-stroke under each domain

Domain I – Patient education on stroke and recovery

Experts agreed that the patient education should comprise of – i) usual time course and speed of recovery, ii) the impact of practice and exercise on recovery, iii) adverse effects of rest and positive effects of activity, iv) the importance of secondary risk factor management, v) managing complications (e.g., spasticity, pain, fatigue, contracture, depression), vi) alternative medicine (including traditional medicines and religious practices), vii) importance of adhering to the exercise program, dosage of the exercise program, viii) role of a caregiver, ix) recovery and return (interaction between severity and prognosis), x) proper positioning techniques, and xi) misconceptions about stroke recovery.

Methods recommended for delivering education included: written information, individual discussions, and phone calls that are individually tailored to each patient's needs,

as well as conducting group sessions wherein testimonials from recovered patients and their caregivers are presented.

Domain II – Methods of exercise prescription

Exercises that are prescribed should be task-specific and individually tailored based on each persons' impairments, goals, and context. These exercises should be reinforced using demonstration and practice. Exercise prescription should include personalized information or messages of personal encouragement.

Additional ways for prescribing exercises may include written or pictorial instructions, videos of exercises, voice-assisted programs, or internet-based applications. Other ways that can support adherence are video recording of patients' exercise performance, splitting the exercise into smaller steps for severe impairments, and gradually increasing difficulty level. Gaming or gamification may also facilitate exercise adherence since it gives a sense of achievement and reinforces exercise behavior.

Domain III - Feedback and supervision

For regular feedback and supervision, maintaining an exercise log, everyday activity status, or updates that are monitored by the medical team could be useful for supporting adherence. Having therapists clear any doubt that patients might have about their exercise prescription, routinely ask patients about their progress, and periodically ask patients to give feedback about the quality of their interaction with therapists will provide a sense of supervision and accountability, thus facilitating adherence.

There should be regular contact with the therapists (in person or via telehealth.) Therapists can use recorded audio/video clips, individual or group discussions for feedback and supervision. Therapists should use standardized assessments to measure clinical outcomes and provide feedback on progress.

Domain IV - Cognitive remediation

The experts in behavioral science and cognitive rehabilitation agreed on prescribing tasks that are focused on functional recovery, planning the exercise centered on individual goals, and understanding the patient's motivation before the treatment session. Motivational interviewing or Motivation Enhancement Therapy could be used to understand their baseline motivational level and establish intrinsic motivation for behavior change. Providing positive feedback and reinforcement for small improvements engenders confidence in patients. Additionally, having a contingency plan for days when exercises could not be performed would prevent abrupt cessation of exercise routine. Using behavioral activation (a treatment technique used in clinical psychology for managing depression) so that patients perform one enjoyable activity each day would keep them motivated to stick to their exercise schedule.

Domain V - Involvement of the family members

Experts suggested that the family should be involved; however, the amount of assistance provided by the family needs to be balanced so as not to promote dependency. Assessing knowledge and understanding of the caregivers on post-stroke exercises is crucial for them to reinforce patients' adherence. Family can be involved by being the patient's exercise partners, or by setting up exercise reminders, or by helping track the patient's progress. Demonstrating

and practicing exercises with family can also enhance the self-efficacy and confidence of caregivers.

Managing the expressed emotions of the family members is important as it may hinder treatment and restrict the patient's autonomy. Rotating family members in the supervision of the patient's activities can help in reducing burnout and maintain novelty in routine.

Domain VI - Involvement of society/ community

Family and friends can interact with the patient on topics not concerning the illness (areas of interest to the patient such as work/ politics/ current affairs/ sports.) Some strategies for involving society include having weekly phone/face-to-face interactions with colleagues, family, and friends, or joining/ creating support groups or associations of families with stroke. Testimonials of recovered patients and their experiences with rehabilitation can be used for motivating other patients. Additional ways to include community are awareness programs for healthy adults, local group exercise for people with stroke, and peer support or exercise buddies.

Domain VII - Promoting self-efficacy

Experts suggested using evidence-based behavior change strategies (e.g., the Capacity Opportunity Motivation-Behavior model[36], or Intervention Mapping approach[25]) and using rehabilitation principles of substitution and optimization. Some suggested strategies to promote self-efficacy include

- Collaborating with patients to devise the best monitoring strategy for them such as exercise practice sheets, paper, electronic diary, or internet-based applications.

- Providing continual support after the termination of the formal therapy program.
- Providing personal graph charts of success that can be generated weekly or monthly.
- Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision.
- Identifying anchors in the day (sleep times/meals/activities - exercise, recreation, social) and setting a general intention of sticking to their exercise program, or developing contingency "if/then" plans.
- Discuss and explore potential barriers that would impede or hinder exercise sessions with patients.
- Overcome barriers using pie-charts, pros versus cons analysis/ identification of cognitive distortions/ downward arrow techniques/ developing a life brochure/ movement, or art-based therapeutic activities.
- Motivation interviewing to help to elicit patients' intention to adhere to exercises and understand their motivation level.

Domain VIII - Motivational strategies

Panel experts suggested that motivation can be facilitated by establishing positive feedback mechanisms at home with caregivers' help to reward adherence. Motivational strategies can be implemented as follows:

- Showing functional improvements or devising individual graphs (every three sessions plus monthly.)
- Having a display board/wall of fame where 'patient of the month' and photos of patients achieving good outcomes could be displayed in a rehabilitation center or common m-health application.

- Using productivity monitoring tools to keep them motivated.
- Maintaining a daily log for positive feelings or gratitude journal, and telephone follow-up where the medical team provides words of encouragement can promote adherence.
- Having video feedback at regular intervals, setting progressive but attainable targets, and involving patients in goal setting may motivate patients to continue exercising.
- Devising wrist bands of different color (coded for level of recovery and mastery of tasks)
- Giving t-shirts or wrist bands of that color and upgrading as they progress to encourage regular exercising.
- Competitions during group sessions among people with similar impairments and provide tokens or badges for improvement that can be exchanged for tangible rewards to make exercising fun and interesting.
- Having an interactive internet-based community where people can add friends to motivate each other to exercise can also be a solution in times of social distancing.

Domain IX - Reminders strategies

Experts agreed on reminder strategies including:

- Calling patients regularly and visiting them weekly or fortnightly.
- Using sticky notes in the patients' homes, tally sheets, pamphlets, or SMS/WhatsApp reminders.
- Therapists can show exercise videos so that patients can accurately remember each exercise steps and use the same video for home practice.

- Use of technology such as sending small feedback surveys, disease information, scientific literature, and progress cards to keep the patients engaged and motivated to continue exercises.
- Using daily logs (electronic or paper-pencil) and weekly reviewing of the exercise log to help stick to a schedule.

DISCUSSION

We aimed to develop a comprehensive set of clinically applicable strategies for optimizing adherence to home-based exercises after a stroke. In a Delphi method, experts from different fields co-construct knowledge and provide recommendations on a particular topic.[37] In our study, we incorporated knowledge from experts in exercise science, behavior science, and experts experienced in community care to develop the set of strategies.

The 10-item open-ended survey, used in the first round, was based on our qualitative study[16] that explored factors influencing adherence among stroke survivors using the Intervention Mapping approach,[38] which is underpinned by the Socio-Ecological Model.[39] Our framework is constructed on the Socio-Ecological Model of behavior change. Since there is limited access to healthcare facilities, higher cost of clinic-based rehabilitation, and lack of transport to hospital setup in low- and middle-income countries, home-based exercise adherence becomes crucial for recovery. The developed adherence strategies are applicable for low- and middle-income countries and could be influential for the success of home-based rehabilitation in the long term.

The suggested strategies were categorized into nine domains, which were in line with the findings in existing systematic reviews. [22, 40, 41, 42] The included studies reported behavior

strategies and theories such as self-efficacy,[22] motivational interventions,[40] social-cognitive theory,[41] activity-monitoring, feedback system, goal-setting,[42] self-regulated exercises,[43] for improving adherence. However, none of the studies had used Delphi approaches and provided broad concepts for enhancing exercise adherence without providing specific context, culture, or techniques for delivering the interventions.

Adherence is affected by multiple factors such as age, self-efficacy, caregiver support, previous exercise behavior, the severity of stroke, and stages of stroke recovery.[19,20,21,44,45] Therefore, the framework of strategies provides the opportunity to individualize the strategies based on each person's impairments, recovery, the severity of stroke, and available support system. The exercises can be tailored depending on the abilities and context of each person.

Adherence to post-stroke rehabilitation is a dynamic process and changes with each stage of recovery, characterized by a higher adherence rate during the initial period of recovery followed by a slow decrease in adherence rate and a stable phase where adherence does not change much.[46] Some strategies such as enhancing self-efficacy, activity scheduling, regular feedback, and monitoring can be initiated during the early phase while strategies such as interim progress tracking, personal graphs, involvement of peer group, gamification of exercises, providing rewards, and reminders can be started gradually to break the monotony of ongoing exercise programs and encourage adherence. Therefore, implementing these adherence strategies early in rehabilitation can be beneficial for maintaining adherent behavior in the long term. The results from a meta-analysis of mixed disease populations demonstrated that adherence is low when perceived disease severity is high among patients with serious illnesses.[47] However, future studies are needed to establish the effects of stroke severity on exercise adherence.

The different sets of strategies within the framework can be deployed to improve exercise adherence after stroke. The framework is useful for stroke survivors, caregivers, and healthcare providers as it offers adherence techniques at a personal, interpersonal, and organizational level. It gives clear recommendations on each strategy's content, different ways of delivering it, healthcare professionals who should design it, and on who might benefit from those strategies.

The uncertain strategies that were not agreed upon by the experts included participating in social events, regular checks by neighbors or games/competition with family/caregivers. Such strategies may improve the social interaction but may not be feasible due to the caregiver's burden after stroke,[48] and family members may not find adequate time for such activities. Other uncertain strategies such as virtual reality, circuit training, or award function were excluded due to the cost, training, and equipment required.[16] Strategies such as educating patients on the location and types of stroke and educational movies were considered redundant for improving exercise adherence.[49] Although social media such as Whatsapp was agreed upon by the experts as a mode of reminder, Whatsapp groups were not preferred as a strategy due to fear of dissemination of inaccurate information among the participants and compromising the privacy of health information.

The key strength of this study lies in the multidisciplinary nature of the expert panel that was recruited, which included specialists in exercise prescription, experts in behavior, and community experts having diverse experiences that contributed to developing a multi-faceted framework of strategies. Due to the pandemic that has compromised clinic-based rehabilitation worldwide, these strategies can be delivered in any healthcare setting, are easy to implement, affordable, and offer a comprehensive set of strategies to facilitate exercise adherence. We have tested the framework of strategies in a recent randomized controlled trial and found it to be effective in improving adherence level among people with stroke.[50] Choosing the strategies

from the framework can help in the pragmatic implementation in clinical practice or research trials. The framework is a useful guide for both clinicians and researchers to select appropriate strategies for enhancing exercise adherence.

We did not include stroke survivors and caregivers in the Delphi panel which we consider a limitation of this study. However, the perceptions of stroke survivors were explored to develop the questionnaire for the first round.[16] The representation of experts from each specialty was unequal which could have influenced the decision-making process that differentiated certain versus uncertain strategies. Hence, some of the strategies deemed uncertain may have clinical relevance for supporting adherence. Moreover, as the open-ended questionnaire was developed from the literature review and opinions of stroke survivors in the previous study, the experts did not get a chance to develop the initial themes.

CONCLUSION

A set of strategies and a framework for enhancing adherence to home-based exercises after stroke has been developed and classified under nine domains: patient education on stroke and recovery, exercise prescription, feedback, and supervision, cognitive remediation, the involvement of family members, the involvement of society, promoting self-efficacy, motivational strategies, and reminder strategies. In countries where home-based exercises are the mainstay of rehabilitation, these strategies could reinforce self-management and facilitate adherence in the long term. Future studies should explore the experiences of stakeholders in implementing these strategies using qualitative methods. The set of strategies could be incorporated in a telerehabilitation model and cost-analysis could be performed in future.

515

516

517

Ethics statement

Institutional Ethics Committee, Kasturba Hospital, Manipal, India approved this study (IEC:355/2017)

Contributorship statement

The study was conceptualized by JMS and MN. AM, JMS, and MN developed the protocol and designed the methodology. AM contacted the experts and prepared the 10-item questionnaire. AD, DLM, GV, SP, STS, ArD, SDK, GN, HS, SKV, SK, BU and CE formed the expert panel and contributed in the development of the framework. AM analysed the data and prepared the first draft with supervision from JMS and MN. All authors have contributed in drafting and revising the manuscript.

Competing Interest

None declared

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Data sharing

No additional data available

References

1. Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. *J. stroke*. 2013;15:128–34.

2. 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. 2016.

3. Hankey G, MacLeod M, Gorelick P, et al. *Warlow's Stroke: Practical Management*. 4th ed. John Wiley & Sons Ltd.; 2019. Chapter 18: Rehabilitation after stroke: evidence, practice, and new directions; 867-877.

4. Pandian JD, Srikanth V, Read SJ, et al. Poverty and stroke in India: A time to act. *Stroke*. 2007;38:3063–9.

5. Craig LE, Wu O, Bernhardt J, et al. Approaches to economic evaluations of stroke rehabilitation. *Int. J. Stroke*. 2014;9:88–100.

6. Legg L. Rehabilitation therapy services for stroke patients living at home: systematic review of randomised trials. *Lancet*. 2004 [cited 2019 Jul 27];363:352–6.

7. Mayo NE. Stroke Rehabilitation at Home. *Stroke*. 2016;47:1685–91.

8. Susan Hillier, Inglis-jassiem G. Rehabilitation for community-dwelling people with stroke : home or centre based ? A systematic review. *Int. J. Stroke*. 2010;5:178–86.

9. Flynn A, Allen NE, Dennis S, et al. Home-based prescribed exercise improves balance-related activities in people with Parkinson' s disease and has benefits similar to centre-based exercise : a systematic review. *J. Physiother*. 2019; Available from: https://doi.org/10.1016/j.jphys.2019.08.003

10. Duncan PW, Horner RD, Reker DM, et al. Adherence to postacute rehabilitation guidelines is associated with functional recovery in stroke. *Stroke*. 2002;33:167–77.

11. Hubbard IJ, Harris D, Kilkenny MF, et al. Adherence to clinical guidelines improves patient outcomes in Australian audit of stroke rehabilitation practice. *Arch. Phys. Med. Rehabil*. 2012;93:965–71. Available from: http://dx.doi.org/10.1016/j.apmr.2012.01.011

12. Gunnes M, Indredavik B, Langhammer B, et al. Associations Between Adherence to the Physical Activity and Exercise Program Applied in the LAST Study and Functional Recovery After Stroke. *Arch. Phys. Med. Rehabil*. 2019. Available from: https://doi.org/10.1016/j.apmr.2019.04.023

13. Shaughnessy M, Resnick BM, Macko RF. Testing a Model of Post-Stroke Exercise Behavior. *Rehabil. Nurs*. 2006;31:15–21. Available from: https://doi.org/10.1002/j.2048-7940.2006.tb00005.x

14. Mahmood A, Solomon JM, English C, et al. Measurement of adherence to home-based exercises among community-dwelling stroke survivors in India. *Physiother. Res. Int.*; 2020 Apr;25(2):e1827. DOI: 10.1002/pri.1827.

15. Chen M, Rimmer JH. Effects of Exercise on Quality of Life in Stroke Survivors. *Stroke*. 2011;42(3):832-8372011.

16. Mahmood A, Nayak P, Kok G, et al. Factors influencing adherence to home-based exercises among community-dwelling stroke survivors in India : a qualitative study. *Eur. J. Physiother*.2019;0:1–7. Available from: https://doi.org/10.1080/21679169.2019.1635641

17. Damush, T.M., Plue, Laurie, Bakas, Tamilyn, et al. Barriers and Facilitators to

Exercise Among Stroke. *Rehabil. Nurs*. 1996;32:253–62.

18. Littlewood C, Mawson S, May S, et al. Understanding the barriers and enablers to implementation of a self-managed exercise intervention: A qualitative study. *Physiother*. (United Kingdom). 2015;101:279–85. Available from: http://dx.doi.org/10.1016/j.physio.2015.01.001

19. Clague-baker N, Carpenter C, Robinson T, et al. A qualitative study exploring patients', with mild to moderate stroke, and their carers' perceptions of healthy lifestyles. *Int J of Ther and Rehab*. 2017; September 2017, Vol 24, No. 9

20. Nicholson S, Sniehotta FF, Wijck F Van, et al. A systematic review of perceived barriers and motivators to physical activity after stroke. *Int. J. Stroke*. 2013;8:357–64. Available from: https://doi.org/10.1111/j.1747-4949.2012.00880.x

21. Sabate E. Adherence to long-term therapies: evidence for action. *World Health Organization*. 2003 [cited 14 September 2019].

22. Fryer CE, Luker JA, McDonnell MN, et al. Self management programmes for quality of life in people with stroke. *Cochrane Database Syst. Rev*. 2016; CD010442.

23. Jordan JL, Holden MA, Mason EE, et al. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Syst Rev*. 2010;2010(1):CD005956. Published 2010 Jan 20. doi:10.1002/14651858.CD005956.pub2.

24. Reunanen MAT, Jarvikoski A, Talvitie U, et al. Individualised home-based rehabilitation after stroke in eastern Finland--the client's perspective. *Health Soc. Care Community*. 2016;24:77–85.

25. Kok G, Gottlieb NH, Peters G-JY, et al. A Taxonomy of Behavior Change Methods; an Intervention Mapping Approach. *Health Psychol. Rev*. 2016;7199:1–32. Available from: http://dx.doi.org/10.1080/17437199.2015.1077155

26. Pill J. The Delphi method: Substance, context, a critique, and an annotated bibliography. *Socioecon. Plann. Sci*. 1971 [cited 2019 Aug 20];5:57–71.

27. Direito A, Walsh D, Hinbarji M, et al. Using the Intervention Mapping and Behavioral Intervention Technology Frameworks: Development of a mHealth Intervention for Physical Activity and Sedentary Behavior Change. *Heal. Educ. Behav*. 2017;1090198117742438. Available from: https://doi.org/10.1177/1090198117742438

28. Peek K, Carey M, Sanson-Fisher R, et al. Aiding patient adherence to physiotherapist-prescribed self-management strategies: an evidence-based behavioural model in practice. *Phys. Ther. Rev*. 2016;21:124–30. Available from: http://dx.doi.org/10.1080/10833196.2016.1226537

29. Kwasnicka D, Dombrowski SU, White M, et al. Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories. *Health Psychol. Rev*. 2016;10:277–96.

30. Picorelli AMA, Pereira LSM, Pereira DS, et al. Adherence to exercise programs for older people is influenced by program characteristics and personal factors: A systematic review. *J. Physiother*. 2014. DOI: 10.1016/j.jphys.2014.06.012

32. Meade LB, Bearne LM, Sweeney LH, et al. Behaviour change techniques associated with adherence to prescribed exercise in patients with persistent musculoskeletal pain: Systematic review. *Br. J. Health Psychol*. 2019;24:10–30.

33. DiMatteo MR, Haskard-Zolnierek KB, Martin LR. Improving patient adherence: a

three-factor model to guide practice. *Health Psychol. Rev.* 2012;6:74–91. Available from: http://www.tandfonline.com/doi/abs/10.1080/17437199.2010.537592

34. Picha KJ, Howell DM. A model to increase rehabilitation adherence to home exercise programmes in patients with varying levels of self-efficacy. *Musculoskeletal Care*. 2017;1–5.

35. Hsieh H-F, Shannon SE. Three Approaches to Qualitative Content Analysis. Qual. *Health Res.* 2005;15:1277–88. Available from: https://doi.org/10.1177/1049732305276687

36. Michie S, Stralen MM Van, West R. The behaviour change wheel : A new method for characterising and designing behaviour change interventions The behaviour change wheel : A new method for characterising and designing behaviour change interventions. *Implement. Sci*. 2011;6:42.

37. Jünger S, Payne SA, Brine J, et al. Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. *Palliat. Med*. 2017;31:684–706.

38. Bartholomew LK, Parcel GS, Kok G. Intervention Mapping: A Process for Developing Theory- and Evidence-Based Health Education Programs. *Heal. Educ. Behav*. 1998;25:545–63.

39. Kok G, Gottlieb NH, Commers M, et al. The Ecological Approach in Health Promotion Programs: A Decade Later. *Am. J. Heal. Promot*. 2008;22:437–41. Available from: https://doi.org/10.4278/ajhp.22.6.437

40. McGrane N, Galvin R, Cusack T, et al. Addition of motivational interventions to exercise and traditional Physiotherapy: A review and meta-analysis. *Physiother*.

(United Kingdom). 2015;101:1–12. Available from: http://dx.doi.org/10.1016/j.physio.2014.04.009

41. Meade LB, Bearne LM, Sweeney LH, et al. Behaviour change techniques associated with adherence to prescribed exercise in patients with persistent musculoskeletal pain: Systematic review. *Br J Health Psychol*. 2019;24(1):10-30. doi:10.1111/bjhp.12324.

42. Peek K, Sanson-Fisher R, Mackenzie L, et al. Interventions to aid patient adherence to physiotherapist prescribed self-management strategies: A systematic review. *Physiother*. (United Kingdom). 2016;102:127–35. Available from: http://dx.doi.org/10.1016/j.physio.2015.10.003

43. Oesch P, Kool J, Fernandez-Luque L, et al. Exergames versus self-regulated exercises with instruction leaflets to improve adherence during geriatric rehabilitation: a randomized controlled trial. *BMC Geriatr*. 2017;17:77.

44. Okezue OC, Nwafor GC, Ezeukwu OA, et al. Adherence to Home Exercise Programmes and its Associated Factors among Patients Receiving Physiotherapy. *Clin. Heal. Promot*. 2019;9:7–14.

45. Eynon, Michael, Foad, Jessica, Downey, John, et al. Assessing the psychosocial factors associated with adherence to exercise referral schemes : A systematic review. *Scand. J. Med. Sci. Sport*. 2019;1–13.

46. Chen J, Tan X. Defining the rehabilitation adherence curve and adherence phases of stroke patients : an observational study. *Patient Prefer. Adherence*. 2017;11:1435–41.

47. Dimatteo MR, Haskard KB, Williams SL. Health Beliefs, Disease Severity, and Patient Adherence: A Meta-Analysis. *Med. Care.* 2007;45:521–8.

48. Jaracz K, Grabowska-Fudala B, Kozubski W. Caregiver burden after stroke: towards a structural model. *Neurol. Neurochir. Pol*. 2012;46:224–32.

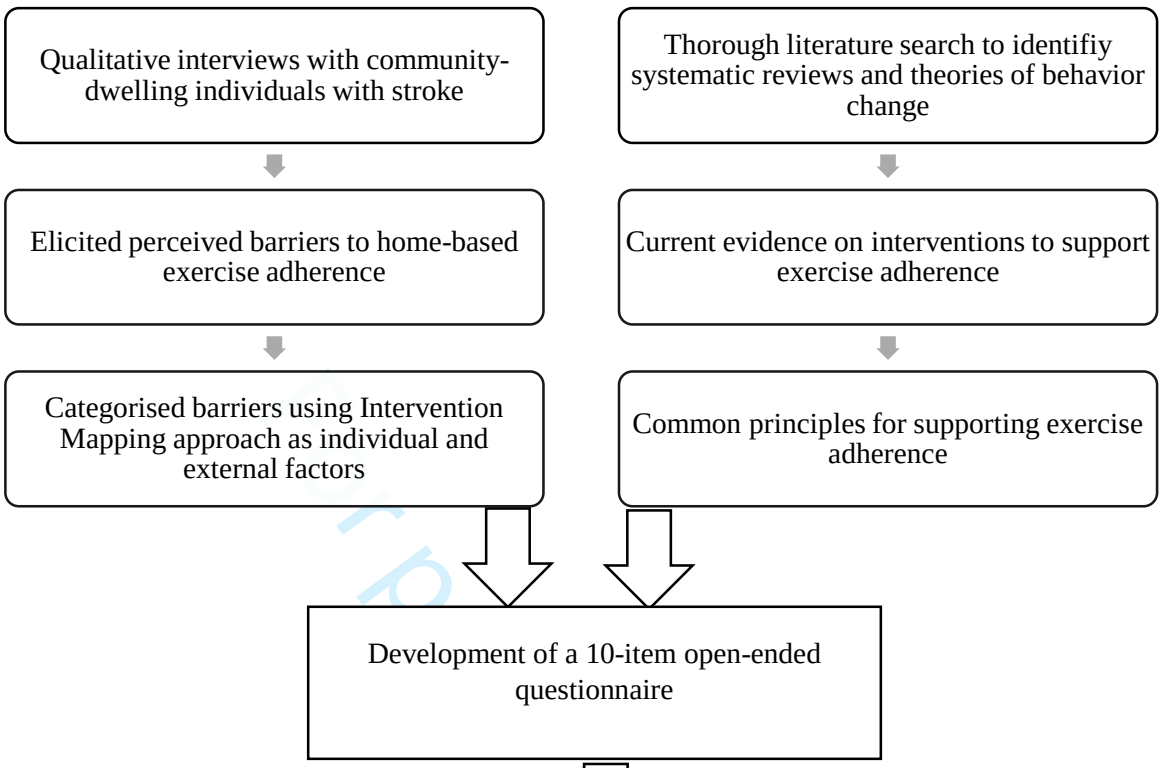
49. Kamalakannan S, Gudlavalleti Venkata M, Prost A, et al. Rehabilitation Needs of Stroke Survivors After Discharge From Hospital in India. *Arch. Phys. Med. Rehabil*. 2016;97:1526-1532.e9. Available from: http://dx.doi.org/10.1016/j.apmr.2016.02.008

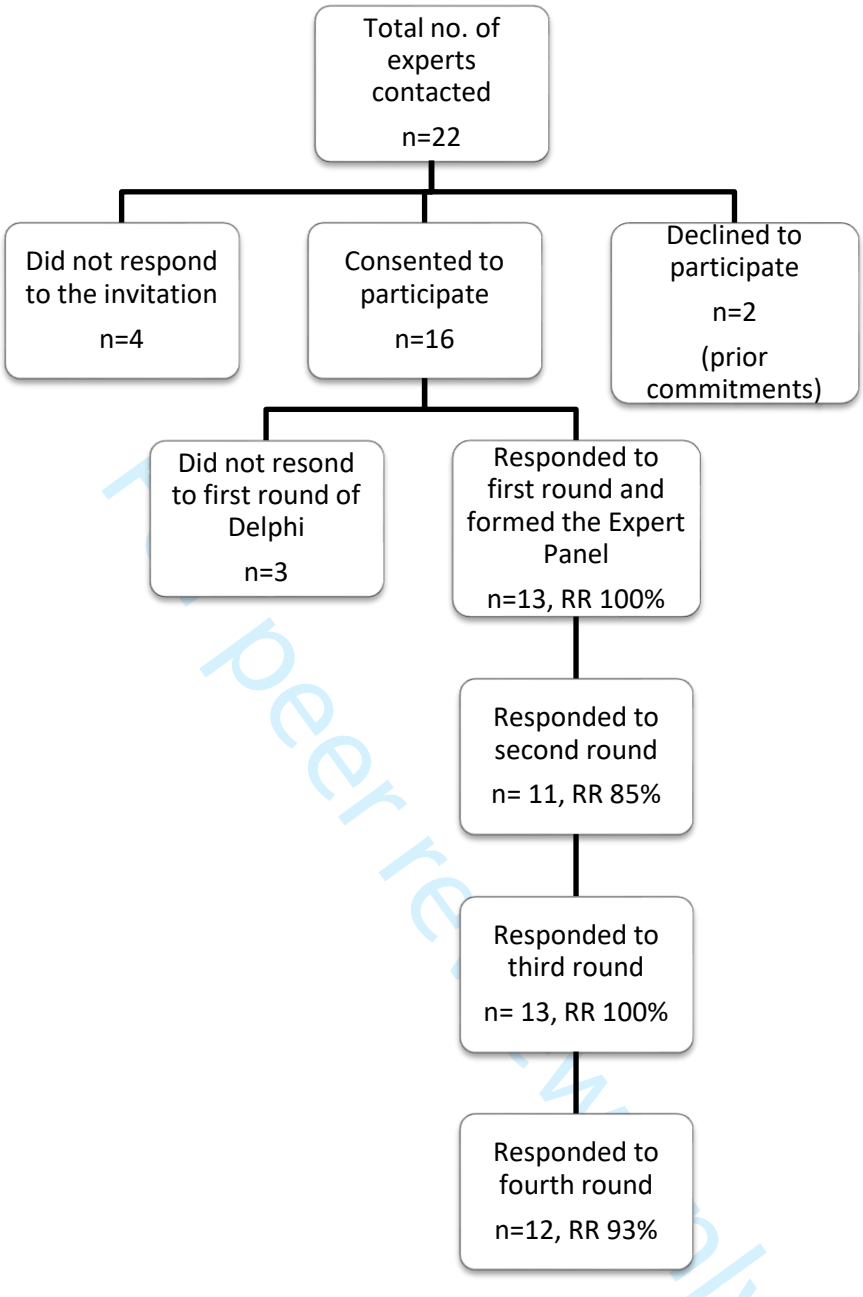
50. Mahmood A, Nayak P, English C, et al. Adherence to home exercises and rehabilitation (ADHERE) after stroke in low-to-middle-income countries: A randomized controlled trial. *Top Stroke Rehabil*. 2021 Jun 28:1-11. doi: 10.1080/10749357.2021.1940800.

Figure Legend

Figure 1: Process of development of adherence framework

Figure 2: Flow of participants and response rate in each round


Qualitative interviews with community-dwelling individuals with stroke
Thorough literature search to identifiy systematic reviews and theories of behavior change
Elicited perceived barriers to home-based exercise adherence
Current evidence on interventions to support exercise adherence
Categorised barriers using Intervention Mapping approach as individual and external factors
Common principles for supporting exercise adherence
Development of a 10-item open-ended questionnaire
4-round Delphi consensus to develop strategies for promoting exercise adherence
Classifying the strategies into ‘what’ and ‘how’ and overarching framework of adherence strategies



***RR, Response rate**

Supplementary file 1: Open-ended questionnaire and summary of responses obtained in Round 1

Q1. Please list the contents that should be included in the patient education about stroke recovery. Suggest a few approaches that could be used for education? Answers*:* Educating about stroke, its usual course of recovery, do's and don'ts, benefits of exercises, complications of stroke and its management, and role of caregiver.
Q2. Please suggest ways for exercise prescription? Answers*:* Prescription of exercises in the form of videos, written instructions, pictures along with demonstration and practice. Prescribing few individualized exercises which are fun and engaging.
Q3. Please suggest ways for taking regular feedback from a patient and clearing any doubts during exercises? Answers: Regular contact with therapists, use of apps or mHealth, monitoring exercises, daily log, and charting of activities.
Q4. Please suggest a way of cognitive remediation for facilitating adherence? Answers: Use of Cognitive Behavior Therapy techniques, motivational interviewing, and counselling. Positive reinforcement and importance to micro gains.
Q5. Please suggest on how family members can help to facilitate adherence? Answers: Emotional support, encouragement, being exercise buddies, setting up reminders, and preventing complications.
Q6. Please suggest ways on how friends, neighbor, colleagues, others can be involved to encourage exercise? Answers*:* Frequent interaction with friends and colleagues, group therapy, association of families, comparison with others.
Q7. Please suggest ways to train the patients to self-monitor & continue exercising and solve problems related to exercise adherence? Answers*:* Monitoring exercises, personal graphs, activity scheduling, promoting self-efficacy, and problem-solving, provide ongoing support.
Q8. Please provide ways for motivating patients to adhere to interventions? Answers*:* Showing improvement and progress, standard and interim assessments, positive feedback mechanisms, telephonic follow up, positive log, and track of consultations.
Q9. Please suggest ways for providing reminders to exercises? Answers*:* Regular follow up, tally sheets, reminders, apps, daily logs, pamphlets, cues and prompts.
Q10. Please suggest features of a web-app/mhealth intervention to facilitate adherence?

Answers*:* Tracking and real-time feedback, activity mapping, virtual games, daily reminders, personalized information, interactive community, progress report, and appreciation.

Supplementary file 2: Level of agreement between experts on uncertain strategies in Round 2

S. No	Unsure strategies	Agreeing experts, n (%) (N=11)	Strategy included for the next round
1.	Activity log/scheduling	8 (73)	Included
2.	Award function every two months	3 (27)	Excluded
3.	Certain use of aids may help them for better balance and self-efficacy	4 (36)	Excluded
4.	Circuit training	1 (9)	Excluded
5.	Coaching methodology	7 (64)	Included
6.	Competition for caregivers and family	2 (18)	Excluded
7.	Contingency charts /plan	9 (82)	Included
8.	Devise color bands coded for level of recovery and mastery of tasks	7 (64)	Included
9.	Information on stroke type and location	4 (36)	Excluded
10.	Home movies for family viewing	4 (36)	Excluded
11.	Individualized program	9 (82)	Included
12.	Involving group sessions	7 (64)	Included
13.	mHealth	7 (64)	Included
14.	Participation in social events	4 (36)	Excluded
15.	Peer support/exercise buddies	8 (73)	Included
16.	Pie chart for social and emotional impact on the patients	3 (27)	Excluded
17.	Posters in the waiting area	7 (64)	Included
18.	Provide tokens and badges for improvement	8 (73)	Included
19.	Psychoeducation	9 (82)	Included
20.	Regular check by neighbors	1 (9)	Excluded
21.	Rotate family members in caregiving	8 (73)	Included
22.	Task-oriented therapy	8 (73)	Included
23.	Virtual reality	4 (36)	Excluded
24.	Wall of fame/display board	7 (64)	Included
25.	Whatsapp group	4 (36)	Excluded

Supplementary file 3: Framework of strategies for facilitating home-based exercise adherence post stroke

S.no	Domain	Strategies	Healthcare provider	Stakeholder
1	**Education about stroke and recovery**	• Education on usual time course and speed of recovery after stroke • Impact of practice and exercise on recovery • Negative effects of rest and positive effects of activity on stroke recovery • Importance of secondary risks management • Managing complications (e.g., spasticity, pain, fatigue, contracture, depression and cognitive changes) • Awareness on interventions without evidence (including traditional medicines and religious practices) • Importance of adhering to the exercise program • Dosage of the exercise program • Information about expected outcomes based on severity • Proper positioning techniques • Misconceptions about stroke recovery • Role of a caregiver Education can be delivered via written information, group sessions, individual discussions, testimonials from recovered patients and caregivers, phone calls	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient, Caregiver
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**

2	**Exercise prescription**	• Relevant exercises for each persons' goals and context • Individually-tailored exercises • Contingency plan and including enough opportunities for independent and autonomous activities • Personalized information/messages on the exercise prescription • Fun and engaging such as gaming or gamification • Use of voice-assisted programs or web-app • Prioritizing and focusing on only a few activities at a time • Demonstration and practice of the prescribed exercises • Written and pictorial instructions (avoid using too many colors and keep it simple and clean) • Videos of exercises • Simple written handout - no more than one printed page • Using a minimum of two and maximum of three mediums (various sensory modalities) when prescribing information • Online tracking application (feed-in everyday progress) • Video recording of patients' exercise performance • Splitting the exercise into smaller and easier steps, and gradually increasing in difficulty	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**

3	**Feedback and supervision**	• Maintaining an exercise log • Daily monitoring of health status and updates of patients by the medical team • Exercise charts - with pictures of each step and a simple breakdown of the activities • Clearing doubts • Obtaining information on progress from patients and caregivers and their experience/quality of care/interaction • Evaluate frequency, form, intensity, and duration of exercise • Maintaining some form of regular contact with therapists - in person or via telehealth • Online web applications that can be accessed by the patients, caregivers, and medical team for recording everyday health status • Recorded audio/video clips to guide the exercise session • Individual and group discussion • Internal feedback • Providing verbal/manual cues at salient points during the exercise, and asking the person what went right and what could be improved • Standardized assessment using clinical outcome measures	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
4	**Cognitive remediation**	• Prescribing functional tasks and planning the exercises focusing on patients' goals • Understanding the exercise behavior of the patient before the treatment session • Educating the patients and caregivers about the benefits of performing exercises • Incorporating a schedule, involving group sessions, and relevant tasks • Positive feedback, reinforcement, and giving importance to micro gains • Assessing intention to exercises- use of Motivation Enhancement Therapy or motivational interviewing • Contingency charts and behavioral activation	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient, caregiver

	Domain	Strategies	Healthcare provider	Stakeholder
5	**Involvement of the family members**	• The family must be involved for a limited amount since it encourages dependency • Management of expressed emotions of the family members that may hinder treatment and restrict the autonomy of the patient • Evaluating caregivers' burden and having frequent sessions to reduce the burnout and to encourage their efforts towards the patient • Assessing knowledge and understanding of the caregivers on the importance of post-stroke exercises • Family can provide emotional support and encouragement • Exercise buddies • Setting up reminders on the patients' phone for anchor points of the day (daily routines/meals/exercise/leisure activities/family time/planned activities) • Developing, demonstrating, and practicing activities with family • Reinforcing adaptive behaviors • Assisting in exercises and preventing complications • Designing a few exercises that involve family members • Rotation of family members for caregiving roles (reduces burnout, improves support, and maintains novelty) • Tracking the progress and delivering rewards to the patient - tangible/intangible	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Caregiver
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
6	**Involvement of society**	• Interaction with colleagues on topics not concerning the illness (preferably the patient's work/politics/current affairs/sports) • Weekly scheduled interactions (phone/face-to-face) with friends, neighbors or colleagues • Creating an association of families caring for stroke or support group	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke	Community

		• Testimonials of recovered patients and their experiences about rehabilitation • Awareness programs for healthy adults • Group exercise for stroke survivors in that particular locality • Peer support or exercise buddies	nurse)	
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
7	**Promoting self-efficacy**	• Use of evidence-based behavior change strategies (e.g., the Capacity Opportunity Motivation-Behavior model, or Intervention Mapping or Coaching Methodology) • Using substitution and optimization principles • Working out with patients on what monitoring will be best for them - exercise practice sheet, paper diary, electronic diary, app • Providing ongoing support once the therapy program has ended • Personal graph chart of success that can be generated weekly or monthly • Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision and support from the caregivers • Setting reminders on the phone or alarms on the clock; identifying anchors in the day (sleep times/meals/activities - exercise, recreation, social) • Setting a general intention of sticking to their exercise program with more specific goals (i.e., intention and "if/then" plans) • Patients could be advised to think of barriers that would impede their exercise sessions, and list ways of overcoming such barriers • Use of pie-charts/pros-con analysis/identification of cognitive distortions/downward arrow techniques for problem analysis and developing a life brochure and art-based therapeutic activities for promoting self-efficacy	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient

	Domain	Strategies	Healthcare provider	Stakeholder
8	**Motivational strategies**	• Tracking and reporting exercise adherence • Showing functional improvement • Measuring performance-repetitions, duration of exercise, exercise intensity, or distance walked • Positive feedback mechanisms at home with the help of caregivers to reward adherence and home activities • Importance to micro gains • Reminding positive experiences with exercise before a stroke • Measuring functional improvements using clinical measures that can help patients appreciate improvements in their health • Telehealth, self-monitoring, diaries • Devise individual graphs (every three sessions plus monthly) • Have a display board/wall of fame where "patient of the month" and photos of patients achieving good outcomes is displayed online or in clinical setup • Telephonic follow-up where the medical team provides words of encouragement • Productivity monitor that has to be filled out by the patient to code the level of functioning for every day in various domains • Maintaining a positive log (paper-pencil or online) two events each day gave the patient a reason to be happy • Feedback at regular intervals using objective outcomes • Setting progressive but achievable targets and involving patients in goal setting • Devising color bands (coded for level of recovery and mastery of tasks). Reinforcing the patients by providing t-shirts or color bands of a particular color that represents certain level of recovery or mastery of task. Upgradation of color bands with progression of tasks.	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient

		• Conducting intra-group competitions for patients (within a given color band) during group sessions • Providing tokens and badges for improvement - which can be exchanged for tangible rewards • Interactive community - can add friends to motivate each other using web app or in community centers		
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
9	**Reminder strategies**	• Calling them on a regular basis and visiting them weekly or fortnightly • Tally sheet, mobile applications, pamphlets, SMS reminders or WhatsApp reminders • Using videos to show exercise steps and giving the same material for home practice • Auditory - use voice recording during the exercise session so that the patient can use the same tapes at home during practice • Alarms/music clips to indicate the time to switch between exercises • Technology - sending small surveys about feedback, information, some scientific literature, and progress card • Daily logs - either electronic or paper-pencil to track mood, exercise, food intake, sleep, social engagement, and grooming activities • Audio – alarms to orient patient to engage in tasks and taking medications. • Weekly reviewing the exercise log • Cues/prompts such as sticky notes in the patients' homes • Follow-up phone calls from the health care professionals • Visible wall posters on exercises	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient, caregiver

BMJ Open

Development of strategies to support home-based exercise adherence after stroke: A Delphi Consensus

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-055946.R2
Article Type:	Original research
Date Submitted by the Author:	06-Dec-2021
Complete List of Authors:	Mahmood, Amreen; Manipal Academy of Higher Education, Physiotherapy; Kasturba Medical College Mangalore, Physiotherapy Deshmukh, Anagha; Manipal College of Health Professions, Clinical Psychology Natarajan, Manikandan ; Manipal College of Allied Health Sciences, Physiotherapy Marsden, Dianne ; Hunter New England Local Health District Vyslysel, Glade; Hunter New England Local Health District Padickaparambil, Sebastian; Manipal College of Allied Health Sciences, Department of Psychology TS, Shwetha; Manipal Academy of Higher Education, Department of Clinical Psychology Direito, Artur; University College London, Health Psychology Kumaran, Senthil ; Manipal College of Health Professions, Physiotherapy N, Girish; Manipal College of Health Professions, Physiotherapy Sachdev, Harpreet ; All India Institute of Medical Sciences, Neurology Kumar Veluswamy, Sundar; MS Ramaiah Medical College Karthikbabu, Suruliraj ; Manipal College of Health Professions Unnikrishnan, B.; Kasturba Medical College Mangalore, Community Medicine English, Coralie; University of Newcastle, School of Health Sciences Solomon, John; Manipal College of Allied Health Sciences, Physiotherapy
Primary Subject Heading:	Neurology
Secondary Subject Heading:	Qualitative research, Health services research, Patient-centred medicine, Sports and exercise medicine, Neurology
Keywords:	Stroke < NEUROLOGY, Rehabilitation medicine < INTERNAL MEDICINE, Stroke medicine < INTERNAL MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Development of strategies to support home-based exercise adherence after stroke: A Delphi Consensus

A. Author and co-authors' names

Amreen Mahmood, Anagha Deshmukh, Manikandan Natarajan, Dianne Lesley Marsden, Glade Vyslysel, Sebastian Padickaparambil, Shwetha Tumkur Shivakumar, Artur Direito, Senthil D. Kumaran, Girish Nandakumar, Harpreet Sachdev, Sundar Kumar Veluswamy, Suruliraj Karthikbabu, Bhaskaran Unnikrishnan, Coralie English, John M. Solomon

B. Corresponding Author Details

Dr. John Solomon M,
Coordinator, Centre for Comprehensive Stroke Rehabilitation and Research,
Head & Associate Professor, Department of Physiotherapy,
Manipal College of Health Professions,
Manipal Academy of Higher Education, Manipal, Karnataka, India
Mail id: john.solomon@manipal.edu

Phone no: +919945670671

Permanent address: Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka, India. Pin code: 576104

C. The full names, institutions, city, and country of all co-authors

1. **Amreen Mahmood**, 1-Department of Physiotherapy, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India. 2 - Department of

Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

2. **Anagha Deshmukh**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

3. **Manikandan Natarajan**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

4. **Dianne Lesley Marsden**, 1-Hunter Stroke Service, Hunter New England Local Health District, New Lambton Heights, NSW, Australia. 2-Priority Research Centre Stroke and Brain Injury, University of Newcastle, Callaghan, NSW, Australia. 3-Brain and Mental Health Program, Hunter Medical Research Institute, New Lambton Heights, NSW, Australia. 4-Centre of Research Excellence in Stroke Rehabilitation and Brain Recovery, Newcastle and Melbourne, Australia.

5. **Glade Vyslysel**, Westlakes Community Rehabilitation Team, Hunter New England Local Health District, NSW, Australia

6. **Sebastian Padickaparambil**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

7. **Shwetha Tumkur Shivakumar**, Department of Clinical Psychology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

8. **Artur Direito**, 1-UCL Centre for Behaviour Change, University College London, London, UK. 2-Yong Loo Lin School of Medicine, National University of Singapore, Singapore.

9. **Senthil D. Kumaran**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

10. **Girish Nandakumar**, Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India

11. **Harpreet Sachdev**, Department of Neurology, All India Institute of Medical Sciences, New Delhi, India.

12. **Sundar Kumar Veluswamy,** Department of Physiotherapy, Ramaiah Medical College, Bengaluru, India.

13. **Suruliraj Karthikbabu,** Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Bengaluru, India.

14. **Bhaskaran Unnikrishnan,** Department of Community Medicine, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India.

15. **Coralie English**, School of Health Sciences and Priority Research, Centre for Stroke and Brain Injury, University of Newcastle, Newcastle, Australia.

16. **John M. Solomon**, 1- Department of Physiotherapy, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India. 2 - Centre for Comprehensive Stroke Rehabilitation and Research, Manipal Academy of Higher Education, Manipal, India.

D. Keywords

Developing Countries; Home-based exercises; Patient-Centered care; Patient Compliance; Stroke rehabilitation

E. Word count (excluding title page, references, figures)

3950

Abstract

Objective: To develop a set of strategies to enhance adherence to home-based exercises after stroke, and an overarching framework to classify these strategies.

Method: We conducted a four-round Delphi consensus (two online surveys, followed by a focus group then a consensus round). The Delphi panel consisted of 13 experts from Physiotherapy, Occupational Therapy, Clinical Psychology, Behavior Science, and Community Medicine. The experts were from India, Australia, and United Kingdom.

Results: In round 1, a 10-item survey using open-ended questions was emailed to panel members and 75 strategies were generated. Of these, 25 strategies were included in round 2 for further consideration. A total of 64 strategies were finally included in the subsequent rounds. In round 3, the strategies were categorized into nine domains – i) patient education on stroke and recovery, ii) method of exercise prescription, iii) feedback and supervision, iv) cognitive remediation, v) involvement of family members, vi) involvement of society, vii) promoting self-efficacy, viii) motivational strategies and ix) reminder strategies. The consensus from 12 experts (93%) led to the development of the framework in round 4.

Conclusion: We developed a framework of comprehensive strategies to assist clinicians in supporting exercise adherence among stroke survivors. It provides practical methods that can be deployed in both research and clinical practices. Future studies should explore stakeholders' experiences and the cost-effectiveness of implementing these strategies.

Strengths and limitations of this study

- The multidisciplinary expert panel consisted of specialists in exercise prescription, behavior science, and community medicine, each having diverse experiences that contributed to the development of this multi-faceted framework of strategies
- We developed strategies specific to low- and middle-income countries that are affordable and provide practical methods of implementation
- One of the limitations of this study was that the individuals with stroke and their caregivers were not included in the Delphi panel
- There was an unequal representation of experts from different specialties

INTRODUCTION

Stroke is one of the leading causes of death and disability across the world.[1] Rehabilitation is recommended to promote recovery, enhance independence, and improve quality of life after a stroke.[2,3] However, healthcare services, and comprehensive stroke rehabilitation centers are often expensive and beyond people's reach.[4,5] Considering the limited access to hospital-based healthcare services after stroke,[4] home-based rehabilitation is often preferred, and sometimes the only option for stroke survivors living in low resource settings.[6,7] Home-based rehabilitation has been shown to have functional and cost benefits.[8,9] Adherence to the home-based regimen is of utmost importance for any intervention to be beneficial.[10,11] Improving adherence to exercise programs after stroke has been shown to improve functional recovery. [12]

Non-adherence to physical exercises is a common problem among stroke survivors.[13] The level of adherence to prescribed home-based exercises among Indian stroke survivors was found to be only 28%.[14] Barriers to exercise after stroke include factors at the individual, interpersonal, organizational, and community levels.[15] Modifiable factors include lack of knowledge about stroke, lack of supervision and motivation, and inadequate exercise prescription by healthcare providers.[15,16,17] Other factors that impact adherence include pain, fear of falls, and post-stroke fatigue.[18,19] In addition, environmental factors such as cost, accessibility, and transport are other barriers for people with chronic stroke. Thus, developing effective strategies that reinforce adherence to home-based exercises is important.[19] As stated by the World Health Organization, "increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments."[20] Therefore, improving adherence to post-stroke rehabilitation may enhance recovery and improve the quality of life among stroke survivors.[21]

Exercise adherence can be improved through motivational interventions, behavioral change strategies, multimedia, follow-up sessions, feedback, cognitive behavior therapy, skill training, self-monitoring, goal setting, coping strategies, and coaching.[21,22,23] However, there is limited information on how to practically incorporate these into clinical practice. Therefore, developing strategies for promoting post-stroke exercise adherence is essential.[12,24] Identifying barriers affecting adherence to exercise, and developing strategies that can be practically implemented by stroke survivors to modify those barriers, increases the potential for improving exercise adherence.[25] Thus, we aimed to develop a set of strategies to facilitate adherence to home-based exercises after stroke and a comprehensive framework to classify these strategies.

METHODS

We obtained approvals from the Institutional Research Committee and Institutional Ethics Committee (IEC:355/2017) of Kasturba Hospital, Manipal, India to conduct this study. This study was a part of a doctoral thesis that was conducted in four phases. In the first phase, we measured the level of exercise adherence among community-living stroke survivors. In the second phase, we conducted qualitative interviews with stroke survivors to understand the factors affecting exercise adherence. Using the themes derived in the second phase, a Delphi study was conducted in the third phase to develop a framework of strategies to support adherence to the home exercise program. The fourth phase involved testing the effectiveness of the developed framework of strategies in a pilot randomized controlled trial. The methods and findings of Phases I, II, and IV are published elsewhere. [14,15,26] The current study (Delphi consensus) describes the process and findings of the third phase of the project.

Participant recruitment

Participants (experts) were recruited using purposive sampling. The criteria for selection were: i) expertise in stroke/ behavior change/ community health, ii) having more than ten years of clinical experience, iii) published in peer-reviewed journals, iv) involvement in translational and collaborative health research, and v) employed in academia, research, or clinical practice.

We identified the experts through the collaborative network of the Centre for Comprehensive Stroke Rehabilitation and Research at the Manipal Academy of Higher Education. We aimed to recruit a majority of experts from India to ensure suggestions were context-specific to low- and middle-income countries. We invited experts to participate in the study from different fields (Physiotherapy, Occupational Therapy, Neurology, Clinical Psychology, Community Medicine, and Behavior Science) to ensure that the strategies were comprehensive and covered multiple aspects of adherence.

Experts were invited via email. Those who agreed to participate gave their written consent and were included in the study. We conducted a four-round Delphi consensus; two online surveys, followed by a focus group to build a set of adherence strategies for home-based exercises based on survey results, then a final online consensus round.[27] Each round took two months. Experts were sent two reminder emails and any non-respondents were excluded from that round. Except for the focus group, the experts were blinded to each other for all rounds, and responses were anonymous. The Delphi rounds were conducted between January 2018 and December 2018. The primary investigator, an experienced stroke physiotherapist (AM)

collected and analyzed the data. The focus group was conducted by another investigator (JS) who has more than 15 years of experience in neurological rehabilitation and qualitative studies.

Data collection and analysis

Round 1

Our previous study explored factors influencing adherence to home-based exercises among stroke survivors through in-depth interviews.[15] Using this information, we categorized the barriers reported by the stroke survivors into internal and external factors using the Intervention Mapping approach.[25] We also performed a literature search in PubMed, Scopus, Web of Science, and Cochrane using the search terms "physical exercises," "adherence," "compliance," "behavior change," and "health behavior." We reviewed studies from the bibliographies of the relevant articles. We identified health behavior change theories and existing strategies/interventions used for improving adherence to long-term therapies. Our review of the literature identified common principles for supporting adherence such as motivation, self-efficacy, social support, the role of family, online health support (mHealth), and behavior change techniques.[27,28,29,30,31,32,33,34] Our findings from the literature and our qualitative study were combined to form a 10-item survey using open-ended questions in SurveyMonkey software (https://www.surveymonkey.com/). The survey was then emailed to the expert panel (Supplementary file 1).

We merged the experts' written responses to perform content analysis[35] and coded the responses using ATLAS.ti 8 software. The responses that were suggested by more than nine out of 13 (70%) experts were considered as 'certain strategies.' Responses that were not

common and suggested by less than nine experts were labeled 'uncertain strategies' for further consideration in round 2.

Round 2

The second survey, consisting of only the 'uncertain strategies', was emailed to the expert panel, and they were asked to agree/disagree on the given strategies, and provide reasons for their opinion. For an 'uncertain strategy' to become a 'certain strategy" it needed to have a majority agreement, i.e., six out of 11 experts. This process resulted in a final set of 64 strategies.

Round 3

We then conducted a face-to-face focus group to collate the included strategies into broader categories. The expert panel was asked to categorize the list of strategies into a specific domain. They also suggested practical ways of implementing the suggested strategies such as: who should design it, the content, how it should be delivered, and target stakeholders. Any experts who could not be present at the focus group were emailed the categories and asked to evaluate the draft framework.

Round 4

The framework of strategies was sent to all the experts for minor modifications and approval. The consensus from the experts led to the development of the final framework. Figure 1 shows the development of the framework.

Patient and Public Involvement

While this Delphi study was conducted among subject experts; opinions of patients and caregivers were used to develop the open-ended questions included in the first round of the Delphi process. Qualitative interviews were conducted among community-dwelling stroke survivors to explore their exercise behavior and barriers to exercise adherence in the second phase of this project. The patients' opinions highlighted that not only patient-related factors, but family, healthcare system, and community-level factors played a role in exercise non-adherence. This information was used in the development of open-ended questions that were included in the first round of the Delphi process. Therefore, the patients' perceptions and needs were incorporated in this study for designing adherence strategies and framework.

RESULTS

We invited 22 experts across India and abroad to participate in the Delphi survey. Thirteen consented to participate in the study and responded to round one (Figure 2). The final panel consisted of physiotherapists (n=7), clinical psychologists (n=3), occupational therapist (n=1), behavior scientist (n=1), and epidemiologist (n=1). Three experts were from Australia, one from the UK, and the remaining experts were from India. Each panel member had more than ten years of clinical experience and multiple publications. (Table 1)

Table 1: Details of participants

Participants	Qualification	Area of work	Expertise	Country
1	Epidemiologist	Research, Academic	Community and rural health Associated with the World Health Organization, Indian Council of Medical Research, and Global Burden of Disease Network	India
2	Occupational Therapist	Clinical	Stroke care and activities of daily living	Australia
3	Physiotherapist	Research, Academic	Stroke rehabilitation and physical activity. Associated with the World Stroke Organization, Stroke Recovery and Rehabilitation Roundtable, and Priority Research Centre for Stroke and Brain Injury	Australia
4	Physiotherapist	Research	Stroke and cardiorespiratory fitness. Associated with the World Stroke Organization and Priority Research Centre for Stroke and Brain Injury	Australia
5	Physiotherapist	Clinical	Stroke rehabilitation	India
6	Physiotherapist	Research, Academic	Stroke rehabilitation	India
7	Physiotherapist	Research, Academic	Community Physiotherapy, and technology in rehabilitation	India
8	Physiotherapist	Research, Academic, Clinical	Physical activity epidemiology	India
9	Physiotherapist	Research, Academic, Clinical	Stroke rehabilitation	India
10	Behavior scientist	Research	Behavior change evidence and theories. Designing and evaluation of behavior change interventions	UK
11	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India
12	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India
13	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioral therapies	India

Round 1

The open-ended survey and the summary of responses received in the first round are provided in supplementary file 1. The content analysis of the responses received in round one yielded a total of 75 strategies. Of these, 50 strategies were suggested by more than nine experts (i.e., >70%) and were considered 'certain.' The remaining 25 were considered 'uncertain' strategies (suggested by less than nine experts) and were included in the next round for further consideration.

Round 2

The response rate for round two was 85% (11 experts.) More than 60% of experts agreed upon 14 out of 25 uncertain strategies and hence those were included. The remaining 11 strategies with less than 60% agreement were excluded. The percentage of agreement for each uncertain strategy is provided in supplementary file 2. We included a total of 64 strategies (50+14) for the subsequent rounds.

Round 3

Six experts (three clinical psychologists, two physiotherapists, and one epidemiologist) participated in the face-to-face focus group. The remaining seven experts responded via email and provided input to the framework. The final 64 strategies were grouped into nine domains (Table 2).

284

285 **Table 2: Grouping of strategies into specific domains**

Items	Domains	Strategies
1	**Patient education on stroke and recovery**	• Patient education about stroke and its treatment • Patient education on adherence • Caregiver education and involvement • Written instructions & pictures • Testimonials from recovered patients • Information on support agencies • Benefits of exercise • Psychoeducation
2	**Exercise prescription**	• Written instructions & pictures • Videos of exercises • Task-oriented training • Prioritizing on a few tasks at a time • Meaningful and relevant exercises • Breaking down exercises into smaller steps • Individualized program • Fun and engaging exercises • mHealth applications • Demonstrate and practice exercises
3	**Feedback and supervision**	• mHealth applications • Activity log • Feedback from patients • Feedback on their progress • Exercise charts with video/audio recording • Asking to tell approach • Clearing doubts by the medical team

		• Regular contact with therapists • Recording exercises for feedback • Regular monitoring • Understand previous exposure with exercises
4	**Cognitive remediation**	• Educating on the benefits of exercise • Motivational interviewing • Cognitive Behavior Therapy techniques • Behavioral activation • Contingency charts • Involving group sessions • Meaningful tasks • Psycho education

5	**Involvement of family members**	• Exercise buddies • Emotional support • Assessing knowledge and understanding of the family on the importance of exercise • Rotate family members in care giving • Activity scheduling
6	**Involvement of society**	• Involvement of friends • Involving group sessions • Modeling behavior • Support and exercise groups • Social comparison
7	**Promoting self-efficacy**	• Personal graph charts • Reduce the number of alternatives presented to the patient • Provide activities that can be done independently • Standardized assessment • Goal setting • Self-efficacy enhancement: using substitution and optimization principles • Ongoing support • Methods of tracking exercises • Coaching methodology • Psycho education
8	**Motivational strategies**	• Patient's videos to show improvement • mHealth (any form of monitoring, consultation, assessment, or therapy delivered using mobile devices) • Interim assessments • Feedback on progress – importance to micro gains • Positive log diary • Wall of fame/display board • Provide tokens and badges for improvement • Methods of education & counseling

		• Devise color bands (coded for level of recovery) • Intra-group competition • Avoid direct comparison
9	**Reminders strategies**	• Reminder phone calls • Use of media • Sticky notes • Alarms/music clips • Auditory - use voice recording during therapy sessions • Logbook • Posters in the waiting area for hospital settings • Whatsapp (or similar) for reminder

Round 4

The final framework of strategies for improving home-based exercise adherence was agreed upon by 12 (93% response rate) experts. The experts agreed that the exercise-related strategies should be designed and delivered by therapists having experience in stroke care such as an occupational therapist, physiotherapist, physiatrist, or stroke nurse. They suggested that the strategies requiring behavioral techniques should be designed and supervised by a licensed clinical psychologist or behavior therapist. In the following section, we have highlighted the key suggestions from the expert committee under each domain. The details of the framework are provided in supplementary file 3.

Strategies for improving adherence to home-based exercises post-stroke under each domain

Domain I – Patient education on stroke and recovery

Experts agreed that the patient education should comprise of: i) usual time course and speed of recovery, ii) the impact of practice and exercise on recovery, iii) adverse effects of rest and positive effects of activity, iv) the importance of secondary risk factor management, v) managing complications (e.g., spasticity, pain, fatigue, contracture, depression), vi) alternative medicine (including traditional medicines and religious practices), vii) importance of adhering to the exercise program, dosage of the exercise program, viii) role of a caregiver, ix) recovery and return (interaction between severity and prognosis), x) proper positioning techniques, and xi) misconceptions about stroke recovery.

Methods recommended for delivering education included: written information, individual discussions, and phone calls that are individually tailored to each patient's needs,

as well as conducting group sessions wherein testimonials from recovered patients and their caregivers are presented.

Domain II – Methods of exercise prescription

Exercises that are prescribed should be task-specific and individually tailored based on each persons' impairments, goals, and context. These exercises should be reinforced using demonstration and practice. Exercise prescription should include personalized information or messages of personal encouragement.

Additional ways for prescribing exercises may include written or pictorial instructions, videos of exercises, voice-assisted programs, or internet-based applications. Other ways that can support adherence are video recording of patients' exercise performance, splitting the exercise into smaller steps for severe impairments, and gradually increasing difficulty level. Gaming or gamification may also facilitate exercise adherence since it gives a sense of achievement and reinforces exercise behavior.

Domain III - Feedback and supervision

For regular feedback and supervision, maintaining an exercise log, everyday activity status, or updates that are monitored by the medical team could be useful for supporting adherence. Having therapists clear any doubt that patients might have about their exercise prescription, routinely ask patients about their progress, and periodically ask patients to give feedback about the quality of their interaction with therapists will provide a sense of supervision and accountability, thus facilitating adherence.

There should be regular contact with the therapists (in person or via telehealth.) Therapists can use recorded audio/video clips, individual or group discussions for feedback and supervision. Therapists should use standardized assessments to measure clinical outcomes and provide feedback on progress.

Domain IV - Cognitive remediation

The experts in behavioral science and cognitive rehabilitation agreed on prescribing tasks that are focused on functional recovery, planning the exercise centered on individual goals, and understanding the patient's motivation before the treatment session. Motivational interviewing or Motivation Enhancement Therapy could be used to understand their baseline motivational level and establish intrinsic motivation for behavior change. Providing positive feedback and reinforcement for small improvements engenders confidence in patients. Additionally, having a contingency plan for days when exercises could not be performed would prevent abrupt cessation of the exercise routine. Using behavioral activation (a treatment technique used in clinical psychology for managing depression) so that patients perform one enjoyable activity each day would keep them motivated to stick to their exercise schedule.

Domain V - Involvement of the family members

Experts suggested that the family should be involved; however, the amount of assistance provided by the family needs to be balanced so as not to promote dependency. Assessing knowledge and understanding of the caregivers on post-stroke exercises is crucial for them to reinforce patients' adherence. Family can be involved by being the patient's exercise partners, or by setting up exercise reminders, or by helping track the patient's progress. Demonstrating

and practicing exercises with family can also enhance the self-efficacy and confidence of caregivers.

Managing the expressed emotions of the family members is important as it may hinder treatment and restrict the patient's autonomy. Rotating family members in the supervision of the patient's activities can help in reducing burnout and maintaining novelty in routine.

Domain VI - Involvement of society/ community

Family and friends can interact with the patient on topics not concerning the illness (areas of interest to the patient such as work/ politics/ current affairs/ sports.) Some strategies for involving society include having weekly phone/face-to-face interactions with colleagues, family, and friends, or joining/ creating support groups or associations of families with stroke. Testimonials of recovered patients and their experiences with rehabilitation can be used for motivating other patients. Additional ways to include community are awareness programs for healthy adults, local group exercise for people with stroke, and peer support or exercise buddies.

Domain VII - Promoting self-efficacy

Experts suggested using evidence-based behavior change strategies (e.g., the Capacity Opportunity Motivation-Behavior model[36], or Intervention Mapping approach[25]) and using rehabilitation principles of substitution and optimization. Some suggested strategies to promote self-efficacy include

- Collaborating with patients to devise the best monitoring strategy for them such as exercise practice sheets, paper, electronic diary, or internet-based applications.

- Providing continual support after the termination of the formal therapy program.
- Providing personal graph charts of success that can be generated weekly or monthly.
- Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision.
- Identifying anchors in the day (sleep times/meals/activities - exercise, recreation, social) and setting a general intention of sticking to their exercise program, or developing contingency "if/then" plans.
- Discuss and explore potential barriers that would impede or hinder exercise sessions with patients.
- Overcome barriers using pie-charts, pros versus cons analysis/ identification of cognitive distortions/ downward arrow techniques/ developing a life brochure/ movement, or art-based therapeutic activities.
- Motivation interviewing to help to elicit patients' intention to adhere to exercises and understand their motivation level.

Domain VIII - Motivational strategies

Panel experts suggested that motivation can be facilitated by establishing positive feedback mechanisms at home with caregivers' help to reward adherence. Motivational strategies can be implemented as follows:

- Showing functional improvements or devising individual graphs (every three sessions plus monthly.)
- Having a display board/wall of fame where 'patient of the month' and photos of patients achieving good outcomes could be displayed in a rehabilitation center or common mHealth application.

- Using productivity monitoring tools to keep them motivated.
- Maintaining a daily log for positive feelings or gratitude journal, and telephone follow-up where the medical team provides words of encouragement can promote adherence.
- Having video feedback at regular intervals, setting progressive but attainable targets, and involving patients in goal setting may motivate patients to continue exercising.
- Devising wrist bands of different colors (coded for level of recovery and mastery of tasks).
- Giving t-shirts or wrist bands of that color and upgrading as they progress to encourage regular exercising.
- Competitions during group sessions among people with similar impairments and provide tokens or badges for improvement that can be exchanged for tangible rewards to make exercising fun and interesting.
- Having an interactive internet-based community where people can add friends to motivate each other to exercise can also be a solution in times of social distancing.

Domain IX - Reminder strategies

Experts agreed on reminder strategies including:

- Calling patients regularly and visiting them weekly or fortnightly.
- Using sticky notes in the patients' homes, tally sheets, pamphlets, or SMS/WhatsApp reminders.
- Therapists can show exercise videos so that patients can accurately remember each exercise step and use the same video for home practice.

- Use of technology such as sending small feedback surveys, disease information, scientific literature, and progress cards to keep the patients engaged and motivated to continue exercises.
- Using daily logs (electronic or paper-pencil) and weekly reviewing of the exercise log to help stick to a schedule.

DISCUSSION

We aimed to develop a comprehensive set of clinically applicable strategies for optimizing adherence to home-based exercises after a stroke. In a Delphi method, experts from different fields co-construct knowledge and provide recommendations on a particular topic.[37] In our study, we incorporated knowledge from experts in exercise science, behavior science, and experts experienced in community care to develop the set of strategies.

The 10-item open-ended survey, used in the first round, was based on our qualitative study[15] that explored factors influencing adherence among stroke survivors using the Intervention Mapping approach,[38] which is underpinned by the Socio-Ecological Model.[39] Our framework is constructed on the Socio-Ecological Model of behavior change. Since there is limited access to healthcare facilities, higher cost of clinic-based rehabilitation, and lack of transport to hospital setup in low resource settings, home-based exercise adherence becomes crucial for recovery. The developed adherence strategies could be influential for the success of home-based rehabilitation in the long term.

The suggested strategies were categorized into nine domains, which were in line with the findings in existing systematic reviews. [21, 40, 41, 42] The included studies reported behavior strategies and theories such as self-efficacy,[21] motivational interventions,[40] social-cognitive

theory,[41] activity-monitoring, feedback system, goal-setting,[42] self-regulated exercises,[43] for improving adherence. However, none of the studies had used Delphi approaches and provided broad concepts for enhancing exercise adherence without providing specific context, culture, or techniques for delivering the interventions.

Adherence is affected by multiple factors such as age, self-efficacy, caregiver support, previous exercise behavior, the severity of stroke, and stages of stroke recovery.[18,19,20,44,45] Therefore, the framework of strategies provides the opportunity to individualize the strategies based on each person's impairments, recovery, the severity of stroke, and available support system. The exercises can be tailored depending on the abilities and context of each person.

Adherence to post-stroke rehabilitation is a dynamic process and changes with each stage of recovery, characterized by a higher adherence rate during the initial period of recovery followed by a slow decrease in adherence rate and a stable phase where adherence does not change much.[46] Some strategies such as enhancing self-efficacy, activity scheduling, regular feedback, and monitoring can be initiated during the early phase while strategies such as interim progress tracking, personal graphs, involvement of peer group, gamification of exercises, providing rewards, and reminders can be started gradually to break the monotony of ongoing exercise programs and encourage adherence. Therefore, implementing these adherence strategies early in rehabilitation can be beneficial for maintaining adherent behavior in the long term. The results from a meta-analysis of mixed disease populations demonstrated that adherence is low when perceived disease severity is high among patients with serious illnesses.[47] However, future studies are needed to establish the effects of stroke severity on exercise adherence.

The different sets of strategies within the framework can be deployed to improve exercise adherence after stroke. The framework is useful for stroke survivors, caregivers, and

healthcare providers as it offers adherence techniques at a personal, interpersonal, and organizational level. It gives clear recommendations on each strategy's content, different ways of delivering it, healthcare professionals who should design it, and one who might benefit from those strategies.

The strategies that were agreed upon by more than 60% of experts were included while the remaining uncertain strategies were excluded. The excluded strategies were participating in social events, regular checks by neighbors, or games/competition with family/caregivers. Such strategies may improve the social interaction but may not be feasible due to the caregiver's burden after stroke,[48] and family members may not find adequate time for such activities. Other uncertain strategies such as virtual reality, circuit training, or award function were excluded due to the cost, training, and equipment required.[15] Strategies such as educating patients on the location and types of stroke and educational movies were considered redundant for improving exercise adherence.[49] Although social media such as Whatsapp was agreed upon by the experts as a mode of reminder, Whatsapp groups were not preferred as a strategy due to fear of dissemination of inaccurate information among the participants and compromising the privacy of health information.

The key strength of this study lies in the multidisciplinary nature of the expert panel that was recruited, which included specialists in exercise prescription, experts in behavior, and community experts having diverse experiences that contributed to developing a multi-faceted framework of strategies. Due to the pandemic that has compromised clinic-based rehabilitation worldwide, these strategies can be delivered in any healthcare setting, are easy to implement, affordable, and offer a comprehensive set of strategies to facilitate exercise adherence. We have tested the framework of strategies in a recent randomized controlled trial and found it to be effective in improving adherence levels among people with stroke.[26] Choosing the strategies from the framework can help in the pragmatic implementation in clinical practice or research

trials. The framework is a useful guide for both clinicians and researchers to select appropriate strategies for enhancing exercise adherence.

We did not include stroke survivors and caregivers in the Delphi panel which we consider a limitation of this study. However, the perceptions of stroke survivors were explored to develop the questionnaire for the first round.[15] The representation of experts from each specialty was unequal which could have influenced the decision-making process that differentiated certain versus uncertain strategies. Hence, some of the strategies deemed uncertain may have clinical relevance for supporting adherence. Moreover, as the open-ended questionnaire was developed from the literature review and opinions of stroke survivors in the previous study, the experts did not get a chance to develop the initial themes.

CONCLUSION

A set of strategies and a framework for enhancing adherence to home-based exercises after stroke has been developed and classified under nine domains: patient education on stroke and recovery, exercise prescription, feedback, and supervision, cognitive remediation, the involvement of family members, the involvement of society, promoting self-efficacy, motivational strategies, and reminder strategies. In countries where home-based exercises are the mainstay of rehabilitation, these strategies could reinforce self-management and facilitate adherence in the long term. Future studies should explore the experiences of stakeholders in implementing these strategies using qualitative methods. The set of strategies could be incorporated in a telerehabilitation model and cost-analysis could be performed in the future.

Ethics statement

Institutional Ethics Committee, Kasturba Hospital, Manipal, India approved this study (IEC:355/2017)

Contributorship statement

The study was conceptualized by JMS and MN. AM, JMS, and MN developed the protocol and designed the methodology. AM contacted the experts and prepared the 10-item questionnaire. AD, DLM, GV, SP, STS, ArD, SDK, GN, HS, SKV, SK, BU and CE formed the expert panel and contributed in the development of the framework. AM analysed the data and prepared the first draft with supervision from JMS and MN. All authors have contributed in drafting and revising the manuscript.

Competing Interest

None declared

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Data sharing

No additional data available

References

1. Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. *J. stroke*. 2013;15:128–34.

2. 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. 2016.

3. Hankey G, MacLeod M, Gorelick P, et al. *Warlow's Stroke: Practical Management*. 4th ed. John Wiley & Sons Ltd.; 2019. Chapter 18: Rehabilitation after stroke: evidence, practice, and new directions; 867-877.

4. Pandian JD, Srikanth V, Read SJ, et al. Poverty and stroke in India: A time to act. *Stroke*. 2007;38:3063–9.

5. Craig LE, Wu O, Bernhardt J, et al. Approaches to economic evaluations of stroke rehabilitation. *Int. J. Stroke*. 2014;9:88–100.

6. Legg L. Rehabilitation therapy services for stroke patients living at home: systematic review of randomised trials. *Lancet*. 2004 [cited 2019 Jul 27];363:352–6.

7. Mayo NE. Stroke Rehabilitation at Home. *Stroke*. 2016;47:1685–91.

8. Susan Hillier, Inglis-jassiem G. Rehabilitation for community-dwelling people with stroke : home or centre based ? A systematic review. *Int. J. Stroke*. 2010;5:178–86.

9. Flynn A, Allen NE, Dennis S, et al. Home-based prescribed exercise improves balance-related activities in people with Parkinson' s disease and has benefits similar to centre-based exercise : a systematic review. *J. Physiother*. 2019; Available from: https://doi.org/10.1016/j.jphys.2019.08.003

10. Duncan PW, Horner RD, Reker DM, et al. Adherence to postacute rehabilitation guidelines is associated with functional recovery in stroke. *Stroke*. 2002;33:167–77.

11. Hubbard IJ, Harris D, Kilkenny MF, et al. Adherence to clinical guidelines improves patient outcomes in Australian audit of stroke rehabilitation practice. *Arch. Phys. Med. Rehabil*. 2012;93:965–71. Available from: http://dx.doi.org/10.1016/j.apmr.2012.01.011

12. Gunnes M, Indredavik B, Langhammer B, et al. Associations Between Adherence to the Physical Activity and Exercise Program Applied in the LAST Study and Functional Recovery After Stroke. *Arch. Phys. Med. Rehabil*. 2019. Available from: https://doi.org/10.1016/j.apmr.2019.04.023

13. Shaughnessy M, Resnick BM, Macko RF. Testing a Model of Post-Stroke Exercise Behavior. *Rehabil. Nurs*. 2006;31:15–21. Available from: https://doi.org/10.1002/j.2048-7940.2006.tb00005.x

14. Mahmood A, Solomon JM, English C, et al. Measurement of adherence to home-based exercises among community-dwelling stroke survivors in India. *Physiother. Res. Int.*; 2020 Apr;25(2):e1827. DOI: 10.1002/pri.1827

15. Mahmood A, Nayak P, Kok G, et al. Factors influencing adherence to home-based exercises among community-dwelling stroke survivors in India : a qualitative study. *Eur. J. Physiother*.2019;0:1–7. Available from: https://doi.org/10.1080/21679169.2019.1635641

16. Damush, T.M., Plue, Laurie, Bakas, Tamilyn, et al. Barriers and Facilitators to Exercise Among Stroke. *Rehabil. Nurs*. 1996;32:253–62.

17. Littlewood C, Mawson S, May S, et al. Understanding the barriers and enablers to

implementation of a self-managed exercise intervention: A qualitative study. *Physiother*. (United Kingdom). 2015;101:279–85. Available from: http://dx.doi.org/10.1016/j.physio.2015.01.001

18. Clague-baker N, Carpenter C, Robinson T, Hagenberg A, Drewry S, Singh S, et al. A qualitative study exploring patients', with mild to moderate stroke, and their carers' perceptions of healthy lifestyles. *Int. J. Ther. Rehabil*. 2017;24:375–84.

19. Nicholson S, Sniehotta FF, Wijck F Van, Greig CA, Johnston M, Mcmurdo MET, et al. Systematic review A systematic review of perceived barriers and motivators to physical activity after stroke. *Int. J. stroke*. 2013;8:357–64. Available from: https://doi.org/10.1111/j.1747-4949.2012.00880.x

20. Sabate E. Adherence to long-term therapies: evidence for action. *World Health Organization*. 2003 [cited 14 September 2019].

21. Fryer CE, Luker JA, McDonnell MN, et al. Self management programmes for quality of life in people with stroke. *Cochrane Database Syst. Rev*. 2016; CD010442.

22. Jordan JL, Holden MA, Mason EE, et al. Interventions to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Syst Rev*. 2010;2010(1):CD005956. Published 2010 Jan 20. doi:10.1002/14651858.CD005956.pub2;

23. Reunanen MAT, Jarvikoski A, Talvitie U, Pyoria O, Harkapaa K. Individualised home-based rehabilitation after stroke in eastern Finland-the client's perspective. *Health Soc. Care Community*. 2016;24:77–85.

24. Chen M, Rimmer JH. Effects of Exercise on Quality of Life in Stroke Survivors. *Stroke*. 2011;42(3):832-837.

25. Kok G, Gottlieb NH, Peters G-JY, Mullen PD, Parcel GS, Ruiter R a C, et al. A Taxonomy of Behavior Change Methods; an Intervention Mapping Approach. *Health Psychol. Rev*. 2016;7199:1–32. Available from: http://dx.doi.org/10.1080/17437199.2015.1077155

26. Mahmood A, Nayak P, English C, et al. Adherence to home exercises and rehabilitation (ADHERE) after stroke in low-to-middle-income countries: A randomized controlled trial. *Top Stroke Rehabil*. 2021 Jun 28:1-11. doi: 10.1080/10749357.2021.1940800.

27. Pill J. The Delphi method: Substance, context, a critique, and an annotated bibliography. *Socioecon. Plann. Sci*. 1971 [cited 2019 Aug 20];5:57–71.

28. Direito A, Walsh D, Hinbarji M, et al. Using the Intervention Mapping and Behavioral Intervention Technology Frameworks: Development of a mHealth Intervention for Physical Activity and Sedentary Behavior Change. *Heal. Educ. Behav*. 2017;1090198117742438. Available from: https://doi.org/10.1177/1090198117742438

29. Peek K, Carey M, Sanson-Fisher R, et al. Aiding patient adherence to physiotherapist-prescribed self-management strategies: an evidence-based behavioural model in practice. *Phys. Ther. Rev*. 2016;21:124–30. Available from: http://dx.doi.org/10.1080/10833196.2016.1226537

30. Kwasnicka D, Dombrowski SU, White M, et al. Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories. *Health Psychol. Rev*. 2016;10:277–96.

31. Picorelli AMA, Pereira LSM, Pereira DS, et al. Adherence to exercise programs for older people is influenced by program characteristics and personal factors: A

systematic review. *J. Physiother*. 2014. DOI: 10.1016/j.jphys.2014.06.012

32. Meade LB, Bearne LM, Sweeney LH, et al. Behaviour change techniques associated with adherence to prescribed exercise in patients with persistent musculoskeletal pain: Systematic review. *Br. J. Health Psychol*. 2019;24:10–30.

33. DiMatteo MR, Haskard-Zolnierek KB, Martin LR. Improving patient adherence: a three-factor model to guide practice. *Health Psychol. Rev.* 2012;6:74–91. Available from: http://www.tandfonline.com/doi/abs/10.1080/17437199.2010.537592

34. Picha KJ, Howell DM. A model to increase rehabilitation adherence to home exercise programmes in patients with varying levels of self-efficacy. *Musculoskeletal Care*. 2017;1–5.

35. Hsieh H-F, Shannon SE. Three Approaches to Qualitative Content Analysis. Qual. *Health Res.* 2005;15:1277–88. Available from: https://doi.org/10.1177/1049732305276687

36. Michie S, Stralen MM Van, West R. The behaviour change wheel : A new method for characterising and designing behaviour change interventions The behaviour change wheel : A new method for characterising and designing behaviour change interventions. *Implement. Sci*. 2011;6:42.

37. Jünger S, Payne SA, Brine J, et al. Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. *Palliat. Med*. 2017;31:684–706.

38. Bartholomew LK, Parcel GS, Kok G. Intervention Mapping: A Process for Developing Theory- and Evidence-Based Health Education Programs. *Heal. Educ. Behav*. 1998;25:545–63..

39. Kok G, Gottlieb NH, Commers M, et al. The Ecological Approach in Health Promotion Programs: A Decade Later. *Am. J. Heal. Promot*. 2008;22:437–41. Available from: https://doi.org/10.4278/ajhp.22.6.437

40. McGrane N, Galvin R, Cusack T, et al. Addition of motivational interventions to exercise and traditional Physiotherapy: A review and meta-analysis. *Physiother*. (United Kingdom). 2015;101:1–12. Available from: http://dx.doi.org/10.1016/j.physio.2014.04.009

41. Meade LB, Bearne LM, Sweeney LH, et al. Behaviour change techniques associated with adherence to prescribed exercise in patients with persistent musculoskeletal pain: Systematic review. *Br J Health Psychol*. 2019;24(1):10-30. doi:10.1111/bjhp.12324.

42. Peek K, Sanson-Fisher R, Mackenzie L, et al. Interventions to aid patient adherence to physiotherapist prescribed self-management strategies: A systematic review. *Physiother*. (United Kingdom). 2016;102:127–35. Available from: http://dx.doi.org/10.1016/j.physio.2015.10.003

43. Oesch P, Kool J, Fernandez-Luque L, et al. Exergames versus self-regulated exercises with instruction leaflets to improve adherence during geriatric rehabilitation: a randomized controlled trial. *BMC Geriatr*. 2017;17:77

44. Okezue OC, Nwafor GC, Ezeukwu OA, et al. Adherence to Home Exercise Programmes and its Associated Factors among Patients Receiving Physiotherapy. *Clin. Heal. Promot*. 2019;9:7–14.

45. Eynon, Michael, Foad, Jessica, Downey, John, et al. Assessing the psychosocial factors associated with adherence to exercise referral schemes : A systematic review. *Scand. J. Med. Sci. Sport*. 2019;1–13.

46. Chen J, Tan X. Defining the rehabilitation adherence curve and adherence phases of stroke patients : an observational study. *Patient Prefer. Adherence*. 2017;11:1435–41.

47. Dimatteo MR, Haskard KB, Williams SL. Health Beliefs, Disease Severity, and Patient Adherence: A Meta-Analysis. *Med. Care.* 2007;45:521–8.

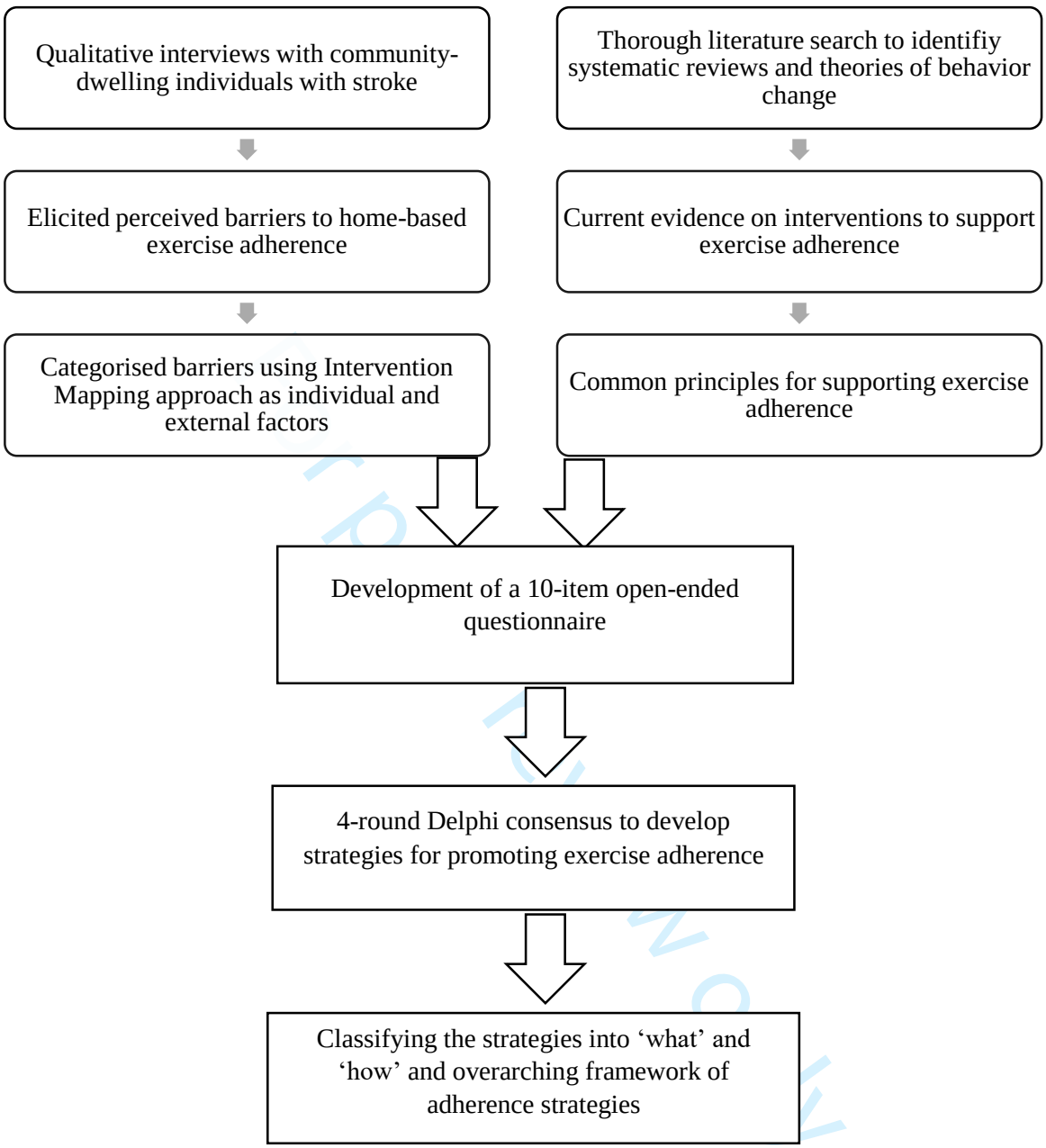
48. Jaracz K, Grabowska-Fudala B, Kozubski W. Caregiver burden after stroke: towards a structural model. *Neurol. Neurochir. Pol*. 2012;46:224–32.

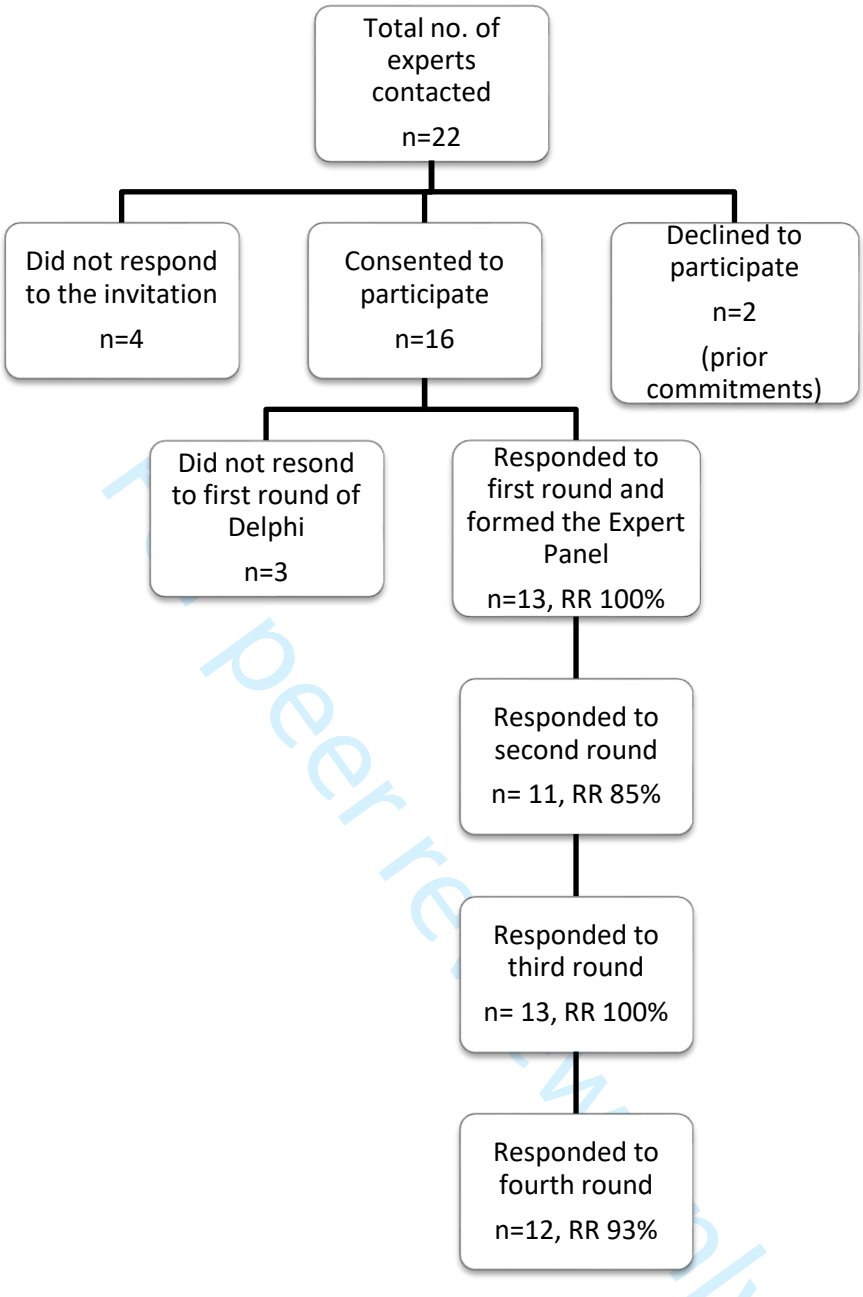
49. Kamalakannan S, Gudlavalleti Venkata M, Prost A, et al. Rehabilitation Needs of Stroke Survivors After Discharge From Hospital in India. *Arch. Phys. Med. Rehabil.* 2016;97:1526-1532.e9. Available from: http://dx.doi.org/10.1016/j.apmr.2016.02.008

Figure Legend

Figure 1: Process of development of adherence framework

Figure 2: Flow of participants and response rate in each round


Qualitative interviews with community-dwelling individuals with stroke
Thorough literature search to identifiy systematic reviews and theories of behavior change
Elicited perceived barriers to home-based exercise adherence
Current evidence on interventions to support exercise adherence
Categorised barriers using Intervention Mapping approach as individual and external factors
Common principles for supporting exercise adherence
Development of a 10-item open-ended questionnaire
4-round Delphi consensus to develop strategies for promoting exercise adherence
Classifying the strategies into ‘what’ and ‘how’ and overarching framework of adherence strategies



***RR, Response rate**

Supplementary file 1: Open-ended questionnaire and summary of responses obtained in Round 1

Q1. Please list the contents that should be included in the patient education about stroke recovery. Suggest a few approaches that could be used for education? Answers*:* Educating about stroke, its usual course of recovery, do's and don'ts, benefits of exercises, complications of stroke and its management, and role of caregiver.
Q2. Please suggest ways for exercise prescription? Answers*:* Prescription of exercises in the form of videos, written instructions, pictures along with demonstration and practice. Prescribing few individualized exercises which are fun and engaging.
Q3. Please suggest ways for taking regular feedback from a patient and clearing any doubts during exercises? Answers: Regular contact with therapists, use of apps or mHealth, monitoring exercises, daily log, and charting of activities.
Q4. Please suggest a way of cognitive remediation for facilitating adherence? Answers: Use of Cognitive Behavior Therapy techniques, motivational interviewing, and counselling. Positive reinforcement and importance to micro gains.
Q5. Please suggest on how family members can help to facilitate adherence? Answers: Emotional support, encouragement, being exercise buddies, setting up reminders, and preventing complications.
Q6. Please suggest ways on how friends, neighbor, colleagues, others can be involved to encourage exercise? Answers*:* Frequent interaction with friends and colleagues, group therapy, association of families, comparison with others.
Q7. Please suggest ways to train the patients to self-monitor & continue exercising and solve problems related to exercise adherence? Answers*:* Monitoring exercises, personal graphs, activity scheduling, promoting self-efficacy, and problem-solving, provide ongoing support.
Q8. Please provide ways for motivating patients to adhere to interventions? Answers*:* Showing improvement and progress, standard and interim assessments, positive feedback mechanisms, telephonic follow up, positive log, and track of consultations.
Q9. Please suggest ways for providing reminders to exercises? Answers*:* Regular follow up, tally sheets, reminders, apps, daily logs, pamphlets, cues and prompts.
Q10. Please suggest features of a web-app/mhealth intervention to facilitate adherence?

Answers*:* Tracking and real-time feedback, activity mapping, virtual games, daily reminders, personalized information, interactive community, progress report, and appreciation.

Supplementary file 2: Level of agreement between experts on uncertain strategies in Round 2

S. No	Unsure strategies	Agreeing experts, n (%) (N=11)	Strategy included for the next round
1.	Activity log/scheduling	8 (73)	Included
2.	Award function every two months	3 (27)	Excluded
3.	Certain use of aids may help them for better balance and self-efficacy	4 (36)	Excluded
4.	Circuit training	1 (9)	Excluded
5.	Coaching methodology	7 (64)	Included
6.	Competition for caregivers and family	2 (18)	Excluded
7.	Contingency charts /plan	9 (82)	Included
8.	Devise color bands coded for level of recovery and mastery of tasks	7 (64)	Included
9.	Information on stroke type and location	4 (36)	Excluded
10.	Home movies for family viewing	4 (36)	Excluded
11.	Individualized program	9 (82)	Included
12.	Involving group sessions	7 (64)	Included
13.	mHealth	7 (64)	Included
14.	Participation in social events	4 (36)	Excluded
15.	Peer support/exercise buddies	8 (73)	Included
16.	Pie chart for social and emotional impact on the patients	3 (27)	Excluded
17.	Posters in the waiting area	7 (64)	Included
18.	Provide tokens and badges for improvement	8 (73)	Included
19.	Psychoeducation	9 (82)	Included
20.	Regular check by neighbors	1 (9)	Excluded
21.	Rotate family members in caregiving	8 (73)	Included
22.	Task-oriented therapy	8 (73)	Included
23.	Virtual reality	4 (36)	Excluded
24.	Wall of fame/display board	7 (64)	Included
25.	Whatsapp group	4 (36)	Excluded

Supplementary file 3: Framework of strategies for facilitating home-based exercise adherence post stroke

S.no	Domain	Strategies	Healthcare provider	Stakeholder
1	**Education about stroke and recovery**	• Education on usual time course and speed of recovery after stroke • Impact of practice and exercise on recovery • Negative effects of rest and positive effects of activity on stroke recovery • Importance of secondary risks management • Managing complications (e.g., spasticity, pain, fatigue, contracture, depression and cognitive changes) • Awareness on interventions without evidence (including traditional medicines and religious practices) • Importance of adhering to the exercise program • Dosage of the exercise program • Information about expected outcomes based on severity • Proper positioning techniques • Misconceptions about stroke recovery • Role of a caregiver Education can be delivered via written information, group sessions, individual discussions, testimonials from recovered patients and caregivers, phone calls	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient, Caregiver
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**

2	**Exercise prescription**	• Relevant exercises for each persons' goals and context • Individually-tailored exercises • Contingency plan and including enough opportunities for independent and autonomous activities • Personalized information/messages on the exercise prescription • Fun and engaging such as gaming or gamification • Use of voice-assisted programs or web-app • Prioritizing and focusing on only a few activities at a time • Demonstration and practice of the prescribed exercises • Written and pictorial instructions (avoid using too many colors and keep it simple and clean) • Videos of exercises • Simple written handout - no more than one printed page • Using a minimum of two and maximum of three mediums (various sensory modalities) when prescribing information • Online tracking application (feed-in everyday progress) • Video recording of patients' exercise performance • Splitting the exercise into smaller and easier steps, and gradually increasing in difficulty	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**

3	**Feedback and supervision**	• Maintaining an exercise log • Daily monitoring of health status and updates of patients by the medical team • Exercise charts - with pictures of each step and a simple breakdown of the activities • Clearing doubts • Obtaining information on progress from patients and caregivers and their experience/quality of care/interaction • Evaluate frequency, form, intensity, and duration of exercise • Maintaining some form of regular contact with therapists - in person or via telehealth • Online web applications that can be accessed by the patients, caregivers, and medical team for recording everyday health status • Recorded audio/video clips to guide the exercise session • Individual and group discussion • Internal feedback • Providing verbal/manual cues at salient points during the exercise, and asking the person what went right and what could be improved • Standardized assessment using clinical outcome measures	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
4	**Cognitive remediation**	• Prescribing functional tasks and planning the exercises focusing on patients' goals • Understanding the exercise behavior of the patient before the treatment session • Educating the patients and caregivers about the benefits of performing exercises • Incorporating a schedule, involving group sessions, and relevant tasks • Positive feedback, reinforcement, and giving importance to micro gains • Assessing intention to exercises- use of Motivation Enhancement Therapy or motivational interviewing • Contingency charts and behavioral activation	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient, caregiver

	Domain	Strategies	Healthcare provider	Stakeholder
5	**Involvement of the family members**	• The family must be involved for a limited amount since it encourages dependency • Management of expressed emotions of the family members that may hinder treatment and restrict the autonomy of the patient • Evaluating caregivers' burden and having frequent sessions to reduce the burnout and to encourage their efforts towards the patient • Assessing knowledge and understanding of the caregivers on the importance of post-stroke exercises • Family can provide emotional support and encouragement • Exercise buddies • Setting up reminders on the patients' phone for anchor points of the day (daily routines/meals/exercise/leisure activities/family time/planned activities) • Developing, demonstrating, and practicing activities with family • Reinforcing adaptive behaviors • Assisting in exercises and preventing complications • Designing a few exercises that involve family members • Rotation of family members for caregiving roles (reduces burnout, improves support, and maintains novelty) • Tracking the progress and delivering rewards to the patient - tangible/intangible	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Caregiver
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
6	**Involvement of society**	• Interaction with colleagues on topics not concerning the illness (preferably the patient's work/politics/current affairs/sports) • Weekly scheduled interactions (phone/face-to-face) with friends, neighbors or colleagues • Creating an association of families caring for stroke or support group	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke	Community

		• Testimonials of recovered patients and their experiences about rehabilitation • Awareness programs for healthy adults • Group exercise for stroke survivors in that particular locality • Peer support or exercise buddies	nurse)	
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
7	**Promoting self-efficacy**	• Use of evidence-based behavior change strategies (e.g., the Capacity Opportunity Motivation-Behavior model, or Intervention Mapping or Coaching Methodology) • Using substitution and optimization principles • Working out with patients on what monitoring will be best for them - exercise practice sheet, paper diary, electronic diary, app • Providing ongoing support once the therapy program has ended • Personal graph chart of success that can be generated weekly or monthly • Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision and support from the caregivers • Setting reminders on the phone or alarms on the clock; identifying anchors in the day (sleep times/meals/activities - exercise, recreation, social) • Setting a general intention of sticking to their exercise program with more specific goals (i.e., intention and "if/then" plans) • Patients could be advised to think of barriers that would impede their exercise sessions, and list ways of overcoming such barriers • Use of pie-charts/pros-con analysis/identification of cognitive distortions/downward arrow techniques for problem analysis and developing a life brochure and art-based therapeutic activities for promoting self-efficacy	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient

	Domain	Strategies	Healthcare provider	Stakeholder
8	**Motivational strategies**	• Tracking and reporting exercise adherence • Showing functional improvement • Measuring performance-repetitions, duration of exercise, exercise intensity, or distance walked • Positive feedback mechanisms at home with the help of caregivers to reward adherence and home activities • Importance to micro gains • Reminding positive experiences with exercise before a stroke • Measuring functional improvements using clinical measures that can help patients appreciate improvements in their health • Telehealth, self-monitoring, diaries • Devise individual graphs (every three sessions plus monthly) • Have a display board/wall of fame where "patient of the month" and photos of patients achieving good outcomes is displayed online or in clinical setup • Telephonic follow-up where the medical team provides words of encouragement • Productivity monitor that has to be filled out by the patient to code the level of functioning for every day in various domains • Maintaining a positive log (paper-pencil or online) two events each day gave the patient a reason to be happy • Feedback at regular intervals using objective outcomes • Setting progressive but achievable targets and involving patients in goal setting • Devising color bands (coded for level of recovery and mastery of tasks). Reinforcing the patients by providing t-shirts or color bands of a particular color that represents certain level of recovery or mastery of task. Upgradation of color bands with progression of tasks.	Licensed psychologist trained in health behavior Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient

		• Conducting intra-group competitions for patients (within a given color band) during group sessions • Providing tokens and badges for improvement - which can be exchanged for tangible rewards • Interactive community - can add friends to motivate each other using web app or in community centers		
	Domain	**Strategies**	**Healthcare provider**	**Stakeholder**
9	**Reminder strategies**	• Calling them on a regular basis and visiting them weekly or fortnightly • Tally sheet, mobile applications, pamphlets, SMS reminders or WhatsApp reminders • Using videos to show exercise steps and giving the same material for home practice • Auditory - use voice recording during the exercise session so that the patient can use the same tapes at home during practice • Alarms/music clips to indicate the time to switch between exercises • Technology - sending small surveys about feedback, information, some scientific literature, and progress card • Daily logs - either electronic or paper-pencil to track mood, exercise, food intake, sleep, social engagement, and grooming activities • Audio – alarms to orient patient to engage in tasks and taking medications. • Weekly reviewing the exercise log • Cues/prompts such as sticky notes in the patients' homes • Follow-up phone calls from the health care professionals • Visible wall posters on exercises	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient, caregiver

Standards for Reporting Qualitative Research (SRQR)*

http://www.equator-network.org/reporting-guidelines/srqr/

	Page/line no(s).
Title and abstract	
Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	1/1-2
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	1/ 4-22
Introduction	
Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	3-4/48-76
Purpose or research question - Purpose of the study and specific objectives or questions	4/79-81
Methods	
Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**	5/101-103
Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	5/107-109
Context - Setting/site and salient contextual factors; rationale**	NA
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	5/93-99
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	4/85-86
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	5/100-107

Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	6/125-129
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	8/168-169
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/de-identification of excerpts	6/128-129
Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	6/129-132
Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	7/149-151

Results/findings

Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	10-21/179-342
Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	Supplementary file 1

Discussion

Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	21-23/350-408
Limitations - Trustworthiness and limitations of findings	23-24/409-416

Other

Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	None
Funding - Sources of funding and other support; role of funders in data collection, interpretation, and reporting	None

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Reference:

O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. **Standards for reporting qualitative research: a synthesis of recommendations.** *Academic Medicine*, Vol. 89, No. 9 / Sept 2014
DOI: 10.1097/ACM.0000000000000388