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

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65 Stroke rehabilitation

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3 81 **Abstract**
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5 82 **Objective:** To develop a set of strategies to enhance adherence to home-based exercises after
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7 83 stroke, and an overarching framework to classify these strategies.
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10 84 **Method:** We conducted a four-round Delphi consensus (two online surveys, followed by a
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12 85 focus group then a consensus round). The Delphi panel included 13 experts from
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14 86 Physiotherapy, Occupational Therapy, Clinical Psychology, Behavior Science, and
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16 87 Community Medicine. The experts were from India, Australia, and United Kingdom.
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20 88 **Results:** In round 1, a 10-item survey using open-ended questions was emailed to panel
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22 89 members and 75 strategies were generated. Of these, 25 strategies required further
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24 90 consideration and were included or excluded in round 2. A total of 64 strategies were finally
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26 91 included for the subsequent rounds. In round 3, the strategies were categorized into nine
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28 92 domains – i) education on stroke and recovery, ii) method of exercise prescription, iii) feedback
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30 93 and supervision, iv) cognitive remediation, v) involvement of family members, vi) involvement
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32 94 of society, vii) promoting self-efficacy, viii) motivational strategies and ix) reminder strategies.
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34 95 The consensus from 12 experts (93%) led to the development of the framework in round 4.
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40 96 **Conclusion:** We developed a framework of comprehensive strategies to assist clinicians in
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42 97 supporting exercise adherence among stroke survivors. It provides practical methods and can
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44 98 be deployed in both research and clinical practices. Future studies should assess the experiences
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46 99 of stakeholders with the set of strategies. The set of strategies can be incorporated for delivering
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48 100 telerehabilitation and cost effectiveness can be evaluated in future.
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3 105 **Strengths and limitations of this study**
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- 5 106 • The multidisciplinary expert panel consisted of specialists in exercise prescription,
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7 behavior science, and community having diverse experiences that contributed to
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9 developing a multi-faceted framework of strategies
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12 109 • The focus of this study was to develop strategies specific to low- and middle- income
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14 countries that are affordable and provide practical methods of implementation
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17 111 • Individuals with stroke and their caregivers were not included in the Delphi panel
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19 112 • There was an unequal representation of experts from different specialty
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124 INTRODUCTION

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

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

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3 149 It is reported that exercise adherence can be improved through motivational
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5 150 interventions, behavioral change strategies, multimedia, follow-up sessions, feedback,
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8 151 cognitive behavior therapy, skill training, self-monitoring, goal setting, coping strategies, and
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10 152 coaching.^{22,23,24} However, there is limited information on how to practically incorporate these
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12 153 into clinical practice. Therefore, developing effective strategies for promoting exercise
13
14 154 adherence is essential.^{12,15} Strategies that identify barriers to adherence, and modify those
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16 155 barriers, can be practically implemented for stroke survivors and have the potential for
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18 156 improving exercise adherence.²⁵ Thus, we aimed to develop a set of strategies to facilitate
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20 157 adherence to home-based exercises after stroke and a comprehensive framework to classify
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22 158 these strategies.
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33 161 **METHODS**

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36 162 We obtained approvals from the Institutional Research Committee and Institutional Ethics
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38 163 Committee (IEC:355/2017) of Kasturba Hospital, Manipal, India for conducting this study.
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43 44 45 165 **Participant recruitment**

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48 166 Participants were recruited using purposive sampling. The criteria for selecting the experts
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50 167 were: i) expertise in stroke/ behavior change/ community health, ii) having more than ten years
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52 168 of clinical experience, iii) published in peer-reviewed journals, iv) involvement in translational
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54 169 and collaborative health research and v) employed in academia, research or clinical practice.
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3 170 We identified the experts through the collaborative network of the Centre for Comprehensive
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5 171 Stroke Rehabilitation and Research at the Manipal Academy of Higher Education. We aimed
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8 172 to recruit the majority of experts from India to ensure suggestions were context-specific to
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10 173 Low-to-Middle-Income Countries. We invited experts to participate in the study from different
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12 174 fields (Physiotherapy, Occupational Therapy, Neurology, Clinical Psychology, Community
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14 175 Medicine, and Behavior Science) to ensure that the strategies were comprehensive and covered
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16 176 multiple aspects of adherence.

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20 177 Experts were invited via emails. Those who agreed to participate gave their written
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22 178 consent and were included in the study. We conducted a four-round Delphi consensus;- two
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24 179 online surveys, followed by a focus group to build a set of adherence strategies for home-based
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26 180 exercises based on survey results, then a final online consensus round.²⁶ Each round lasted for
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28 181 two months. Experts who did not respond even after a biweekly reminder were excluded from
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30 182 that round. Except for the focus group, the experts were blinded to each other for all rounds,
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32 183 and responses were anonymous. The duration of the Delphi rounds was from January 2018 to
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34 184 December 2018. The primary investigator, an experienced stroke physiotherapist (AM)
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36 185 collected and analyzed the data. The focus group was conducted by another investigator (JS)
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38 186 who has more than 15 years of experience in neurological rehabilitation and qualitative studies.
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189 **Data collection and analysis**

190 Round 1

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

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3 193 barriers reported by the stroke survivors into internal and external factors using the Intervention
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5 194 Mapping approach.²⁵ We also performed a literature search in PubMed, Scopus, Web of
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8 195 Science, and Cochrane using the search terms "physical exercises," "adherence," "compliance,"
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10 196 "behavior change," and "health behavior." We reviewed studies from the bibliographies of the
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12 197 relevant articles. We identified health behavior change theories and existing
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14 198 strategies/interventions used for improving adherence to long-term therapies. Our review of
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17 199 the literature led to identifying common principles for supporting adherence such as
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19 200 motivation, self-efficacy, social support, the role of family, online health support (mHealth),
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21 201 and behavior change techniques.^{28,29,30,31,32,33,34} Our findings from the literature and our
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23 202 qualitative study were combined to form the 10-item survey using open-ended questions in
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25 203 SurveyMonkey software (<https://www.surveymonkey.com/>). The survey was then emailed to
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27 204 the expert panel (Supplementary file 1)

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32 205 For analyzing the round 1 data, we merged the experts' written responses to perform
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34 206 content analysis³⁵ and coded the responses using Atlas.Ti8 software. The responses that were
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36 207 suggested by more than nine out of 13 (70%) experts were considered as 'certain strategies.'
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38 208 Responses that were not common and suggested by less than nine experts were labeled
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40 209 'uncertain strategies' for further consideration in round 2.

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50 212 The second survey, consisting of only the 'uncertain strategies', was emailed to the expert
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52 213 panel, and they were asked to agree/disagree on the given strategies, and provide reasons for
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54 214 their opinion. For an 'uncertain strategy' to become a 'certain strategy' it needed to have a
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56 215 majority agreement, i.e., six out of 11 experts. This process results in a final set of 64 strategies.

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56 217 Round 3
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9 218 We then conducted a face-to-face focus group to collate the included strategies into broader
10 219 categories. The expert panel was asked to categorize the list of strategies into a specific domain.

11 220 They also suggested practical ways of implementing the suggested strategies such as – who
12 221 should design it, the content, how it should be delivered, and towards who the strategies were
13 222 to be targeted. The remaining experts, who could not be present at the focus group, were
14 223 emailed the categories and were requested to evaluate the draft framework.

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2526 225 Round 4
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29 226 The framework of strategies was sent to all the experts for minor modifications and approval.
30 227 The consensus from the experts led to the development of the final framework. Figure 1 shows
31 228 the development of the framework.

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41 230 **Patient and Public Involvement**

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44 231 The present study was conceived to provide guidance to facilitate adherence to home exercise
45 232 programs. As a first step, it was felt important to understand patient experiences in exercise
46 233 adherence. Towards this end, qualitative interviews were conducted among community-
47 234 dwelling stroke survivors to explore their exercise behavior and barriers to exercise
48 235 adherence. The patients' opinions highlighted that not only patient-related factors but family,
49 236 healthcare system, and community level factors played a role in exercise non-adherence. This
50 237 information was used in the development of open-ended questions that were asked to subject
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3 238 experts for the first round of the Delphi process. Therefore, the patients' perceptions and
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5 239 needs were incorporated in this study for designing adherence strategies and framework.
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8 240 After the strategies were developed by experts, they were tested in a subsequent RCT which
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10 241 showed that these strategies significantly improved exercise adherence levels among stroke
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12 242 survivors.
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23 245 **RESULTS**

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26 246 We invited 22 experts across India and abroad to participate in the Delphi survey. Only 13
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28 247 experts consented to participate in the study and responded to round one (Figure 2). The final
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30 248 panel consisted of physiotherapists (n=7), clinical psychologists (n=3), occupational therapist
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32 249 (n=1), behavior scientist (n=1), and epidemiologist (n=1). Three experts were from Australia,
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34 250 one from the UK, and the remaining experts were from India. Each panel member had more
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36 251 than ten years of clinical experience and multiple publications. (Table 1)
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253 **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

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3 256 **Round 1**
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6 257 Thirteen experts responded to round one and formed the Delphi panel. The open-ended
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8 258 survey and the summary of responses received in the first round are provided in
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10 259 supplementary file 1. The content analysis of the responses received in round one yielded a
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12 260 total of 75 strategies. Of these, more than nine experts suggested fifty strategies; thus, they
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14 261 were considered 'certain.' Less than nine experts suggested 25 strategies, and those were
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16 262 considered 'uncertain' strategies.
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23 264 **Round 2**
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26 265 The response rate for round two was 85% (11 experts.) Frequency analysis yielded 14 uncertain
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28 266 strategies that were agreed upon by most experts (6 out of 11.) The remaining 11 strategies
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30 267 were excluded. The percentage of agreement for each uncertain strategy is provided in
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32 268 supplementary file 2. We included a total of 64 strategies (50+14) for the subsequent rounds.
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40 270 **Round 3**
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43 271 Six experts (three clinical psychologists, two physiotherapists, and one epidemiologist)
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45 272 participated in the face-to-face focus group. The remaining seven experts responded via emails
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47 273 and provided inputs on the framework. The final 64 strategies were grouped into nine domains
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49 274 (Table 2).
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278 **Table 2: Grouping of strategies into specific domains**

Items	Domains	Strategies
1	Education about stroke and recovery	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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

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4		<ul style="list-style-type: none">• Regular monitoring
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6		<ul style="list-style-type: none">• Understand previous exposure with exercises
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8	4	Cognitive remediation
9		<ul style="list-style-type: none">• Educating on the benefits of exercise
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11		<ul style="list-style-type: none">• Motivational interviewing
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13		<ul style="list-style-type: none">• Cognitive Behavior Therapy techniques
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15		<ul style="list-style-type: none">• Behavioral activation
16		
17		<ul style="list-style-type: none">• Contingency charts
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19		<ul style="list-style-type: none">• Involving group sessions
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21		<ul style="list-style-type: none">• Meaningful tasks
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23		<ul style="list-style-type: none">• Psycho education
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5	Involvement of family members	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Involvement of friends • Involving group sessions • Modeling behavior • Support and exercise groups • Social comparison
7	Promoting self-efficacy	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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

		<ul style="list-style-type: none"> • Devise color bands (coded for level of recovery) • Intra-group competition • Avoid direct comparison
9	Reminders strategies	<ul style="list-style-type: none"> • 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

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3 **282 Round 4**
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6 283 The final framework of strategies for improving home-based exercise adherence was agreed
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8 284 upon by 12 (93% response rate) experts. The experts agreed that the exercise-related strategies
9
10 285 should be designed and delivered by therapists having experience in stroke care such as an
11
12 286 occupational therapist, physiotherapist, physiatrist, or stroke nurse. They suggested that the
13
14 287 strategies requiring behavioral techniques should be designed and supervised by a licensed
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16 288 clinical psychologist or behavior therapist. In the following section, we have highlighted the
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18 289 key suggestions from the expert committee under each domain. The details of the framework
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20 290 are provided in supplementary file 3.
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29 292 Strategies for improving adherence to home-based exercises post-stroke under each domain

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32 293 *Domain I - Education on stroke and recovery.*
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35 294 Experts agreed that the education should comprise of – i) usual time course and speed of
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37 295 recovery, ii) the impact of practice and exercise on recovery, iii) adverse effects of rest and
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39 296 positive effects of activity, iv) the importance of secondary risk factor management, v)
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41 297 managing complications (e.g., spasticity, pain, fatigue, contracture, depression), vi)
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43 298 interventions without evidence (including traditional medicines and religious practices), vii)
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45 299 adherence to the exercise program, dosage of the exercise program, viii) role of a caregiver, ix)
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47 300 recovery and return (interaction between severity and prognosis), x) proper positioning
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49 301 techniques, and xi) misconceptions about stroke recovery.
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54 302 Methods recommended for delivering education included: written information,
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56 303 individual discussions, and phone calls that are individually tailored to each patient's needs,
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3 304 as well as conducting group sessions wherein testimonials from recovered patients and their
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5 305 caregivers are presented.
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11 307 *Domain II – Methods of exercise prescription*
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14 308 Exercises that are prescribed should be task-specific and individually tailored based on each
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16 309 persons' impairments, goals, and context. These exercises should be reinforced using
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18 310 demonstration and practice. Exercise prescription should include personalized information or
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21 311 messages of personal encouragement.
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24 312 Additional ways for prescribing exercises may include written or pictorial instructions,
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26 313 videos of exercises, voice-assisted programs, or internet-based applications. Other ways that
27
28 314 can support adherence are video recording of patients' exercise performance, splitting the
29
30 315 exercise into smaller steps for severe impairments, and gradually increasing difficulty level.
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33 316 Gaming or gamification may also facilitate exercise adherence since it gives a sense of
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35 317 achievement and reinforces exercise behavior.
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42 319 *Domain III - Feedback and supervision*
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45 320 For regular feedback and supervision, maintaining an exercise log or everyday activity status,
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47 321 or updates that are monitored by the medical team could be useful for supporting adherence.
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49 322 Having therapists clear any doubt that patients might have about their exercise prescription,
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51 323 routinely ask patients about their progress, and periodically ask patients to give feedback about
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53 324 the quality of their interaction with therapists will provide a sense of supervision and
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56 325 accountability, thus facilitating adherence.
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3 326 There should be regular contact with the therapists (in person or via telehealth.)
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5 327 Therapists can use recorded audio/video clips, individual or group discussions for feedback
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8 328 and supervision. Therapists should use standardized assessments to measure clinical outcomes
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10 329 and provide feedback on progress.

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16 331 *Domain IV - Cognitive remediation*

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19 332 The experts in behavioral science and cognitive rehabilitation agreed on prescribing tasks that
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21 333 are focused on functional recovery, planning the exercise centered on individual goals, and
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23 334 understanding the patient's motivation before the treatment session. Motivational interviewing
24
25 335 or Motivation Enhancement Therapy could be used to understand their baseline motivational
26
27 336 level and establish intrinsic motivation for behavior change. Providing positive feedback and
28
29 337 reinforcement for small improvements engenders confidence in patients. Additionally, having
30
31 338 a contingency plan for days when exercises could not be performed would prevent abrupt
32
33 339 cessation of exercise routine. Using behavioral activation so that patients perform one
34
35 340 enjoyable activity each day would keep them motivated for sticking to exercise schedule.

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44 342 *Domain V - Involvement of the family members*

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47 343 Experts suggested that the family should be involved; however, the amount of assistance
48
49 344 provided by the family needs to be balanced so as not to promote dependency. Assessing
50
51 345 knowledge and understanding of the caregivers on post-stroke exercises is crucial for them to
52
53 346 reinforce patients' adherence. Family can be involved by being the patient's exercise partners,
54
55 347 or by setting up exercise reminders, or by helping track the patient's progress. Demonstrating

1
2
3 348 and practicing exercises with family can also enhance the self-efficacy and confidence of
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5 349 caregivers.

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8 350 Managing the expressed emotions of the family members is important as it may hinder
9
10 351 treatment and restrict the patient's autonomy. Rotating family members in the supervision of
11
12 352 the patient's activities can help in reducing burnout and maintain novelty in routine.

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18 354 *Domain VI - Involvement of society/ community*

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21 355 Family and friends can interact with the patient on topics not concerning the illness (areas of
22
23 356 interest to the patient such as work/ politics/ current affairs/ sports.) Some strategies for
24
25 357 involving society include having weekly phone/face-to-face interactions with colleagues,
26
27 358 family, and friends, or joining/ creating support groups or associations of families with stroke.
28
29 359 Testimonials of recovered patients and their experiences with rehabilitation can be used for
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31 360 motivating other patients. Additional ways to include community are awareness programs for
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33 361 healthy adults, local group exercise for people with stroke, and peer support or exercise
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35 362 buddies.

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41 364 *Domain VII - Promoting self-efficacy*

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44 365 Experts suggested using evidence-based behavior change strategies (e.g., the Capacity
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46 366 Opportunity Motivation-Behavior model³⁶, or Intervention Mapping approach²⁵) and using
47
48 367 rehabilitation principles of substitution and optimization. Some suggested strategies to promote
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50 368 self-efficacy include

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57 369
 - Collaborating with patients to devise the best monitoring strategy for them such as

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59 370 exercise practice sheets, paper, electronic diary, or internet-based applications.

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3 371 • Providing continual support after the termination of the formal therapy program.
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6 372 • Providing personal graph charts of success that can be generated weekly or monthly.
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8 373 • Ensuring an adequate number of activities in which the patient can engage
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10 374 independently or with minimal supervision.
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12 375 • Identifying anchors in the day (sleep times/meals/activities - exercise, recreation,
13 376 social) and setting a general intention of sticking to their exercise program, or
14 377 developing contingency "if/then" plans.
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17 378 • Discuss and explore potential barriers that would impede or hinder exercise sessions
18 379 with patients.
19
20 380 • Overcome barriers using pie-charts, pros versus cons analysis/ identification of
21 381 cognitive distortions/ downward arrow techniques/ developing a life brochure/
22 382 movement, or art-based therapeutic activities.
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24 383 • Motivation interviewing to help to elicit patients' intention to adhere to exercises and
25 384 understand their motivation level.
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386 *Domain VIII - Motivational strategies*

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

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

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3 395 • Using productivity monitor tools to keep them motivated.
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6 396 • Maintaining a positive log and telephonic follow-up where the medical team provides
7
8 397 words of encouragement can promote adherence.
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10 398 • Having video feedback at regular intervals, setting progressive but attainable targets,
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12 399 and involving patients in goal setting may motivate patients to continue exercising.
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15 400 • Devising color bands (coded for level of recovery and mastery of tasks)
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17 401 • Giving t-shirts or wrist bands of that color and upgrading as they progress to encourage
18
19 402 regular exercising.
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22 403 • Competitions during group sessions among people with similar impairments and
23
24 404 provide tokens or badges for improvement that can be exchanged for tangible rewards
25
26 405 to make exercising fun and interesting.
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29 406 • Having an interactive internet-based community where people can add friends to
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31 407 motivate each other to exercise can also be a solution in times of social distancing.
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37 409 *Domain IX - Reminders strategies*
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40 410 Experts agreed on reminder strategies including:
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43 411 • Calling patients regularly and visiting them weekly or fortnightly.
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45 412 • Using sticky notes in the patients' homes, tally sheets, pamphlets, or SMS/WhatsApp
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47 413 reminders.
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50 414 • Therapists using videos to show the exercise steps and prescribe the same for home
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52 415 practice.
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55 416 • Use of technology such as sending small feedback surveys, disease information,
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57 417 scientific literature, and progress cards to keep the patients engaged and motivated to
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59 418 continue exercises.
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3 419 • Using daily logs (electronic or paper-pencil) and weekly reviewing the exercise log to
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6 420 help stick to a schedule.
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11 422 **DISCUSSION**
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15 423 We aimed to develop a comprehensive set of clinically applicable strategies for
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17 424 optimizing adherence to home-based exercises after a stroke. In a Delphi method, experts from
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19 425 different fields co-construct knowledge and provide recommendations on a particular topic.³⁷
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21 426 In our study, we incorporated knowledge from experts in exercise science, behavior science,
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23 427 and experts experienced in community care to develop the set of strategies.
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27 428 The 10-item open-ended survey, used in the first round, was based on our qualitative
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29 429 study¹⁶ that explored factors influencing adherence among stroke survivors using the
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31 430 Intervention Mapping approach,³⁸ which is underpinned by the Socio-Ecological Model.³⁹ Our
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33 431 framework is constructed on the Socio-Ecological Model of behavior change. Since there is
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35 432 limited access to healthcare facilities, higher cost of clinic-based rehabilitation, and lack of
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37 433 transport to hospital setup in low- and middle-income countries, home-based exercise
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39 434 adherence becomes crucial for recovery. Thus, the developed adherence strategies are
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41 435 applicable for low- and middle-income countries and could be influential for the success of
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43 436 home-based rehabilitation in the long term.
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49 437 The suggested strategies were categorized into nine domains, which were in line with
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51 438 the findings in existing systematic reviews.^{22, 40, 41, 42} The included studies reported behavior
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53 439 strategies and theories such as self-efficacy,²² motivational interventions,⁴⁰ social-cognitive
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55 440 theory,⁴¹ activity-monitoring, feedback system, goal-setting,⁴² self-regulated exercises,⁴³ for
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57 441 improving adherence. However, none of the studies had used Delphi approaches and provided
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3 442 broad concepts for enhancing exercise adherence without providing specific context, culture,
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5 443 or techniques for delivering the interventions.
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8 444 Adherence is affected by multiple factors such as age, self-efficacy, caregiver support,
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10 445 previous exercise behavior, the severity of stroke, and stages of stroke recovery.^{19,20,21,44,45}
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12 446 Therefore, the framework of strategies provides the opportunity to individualize the strategies
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14 447 based on each person's impairments, recovery, the severity of stroke, and available support
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16 448 system. The exercises can be tailored depending on the abilities and context of each person.
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20 449 Adherence to post-stroke rehabilitation is a dynamic process and changes with each
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22 450 stage of recovery characterized by a rapid increase phase, slow decrease phase, and a stable
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24 451 phase.⁴⁶ Some strategies such as enhancing self-efficacy, activity scheduling, regular feedback,
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26 452 and monitoring can be initiated during the early phase while strategies such as interim progress
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28 453 tracking, personal graphs, involvement of peer group, gamification of exercises, providing
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30 454 rewards, and reminders can be started gradually to break the monotony of ongoing exercise
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32 455 programs and encourage adherence. Therefore, implementing these adherence strategies early
33
34 456 in rehabilitation can be beneficial for maintaining adherent behavior in the long term. The
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36 457 results from a meta-analysis of mixed disease populations demonstrated that adherence is low
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38 458 when perceived disease severity is high among patients with serious illnesses.⁴⁷ However,
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40 459 future studies are needed to establish the effects of stroke severity on exercise adherence.
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47 460 The different sets of strategies within the framework can be deployed to improve
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49 461 exercise adherence after stroke. The framework is useful for stroke survivors, caregivers, and
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51 462 healthcare providers as it offers adherence techniques at a personal, interpersonal, and
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53 463 organizational level. It gives clear recommendations on each strategy's content, different ways
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55 464 of delivering it, healthcare professionals who should design it, and on who might benefit from
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57 465 those strategies.
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3 466 The uncertain strategies that were not agreed upon by the experts included participating
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6 467 in social events, regular checks by neighbors or games/competition with family/caregivers.
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8 468 Such strategies may improve the social interaction but may not be feasible due to the caregiver's
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10 469 burden after stroke,⁴⁸ and family members may not find adequate time for such activities. Other
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12 470 uncertain strategies such as virtual reality, circuit training, or award function were excluded
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14 471 due to the cost, training, and equipment required.¹⁶ Strategies such as educating patients on the
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16 472 location and types of stroke and educational movies were considered redundant for improving
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18 473 exercise adherence.⁴⁹ Although social media such as Whatsapp was agreed upon by the experts
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20 474 as a mode of reminder, Whatsapp groups were not preferred as a strategy due to fear of
21
22 475 dissemination of inaccurate information among the participants and compromising the privacy
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24 476 of health information.
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29 477 The key strength of this study lies in the multidisciplinary nature of the expert panel
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31 478 that was recruited, which includes specialists in exercise prescription, experts in behavior, and
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33 479 community experts having diverse experiences that contributed to developing a multi-faceted
34
35 480 framework of strategies. Most of the strategies are easy to implement, suitable for low-resource
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37 481 settings, affordable, and offer a comprehensive set for facilitating exercise adherence. We have
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39 482 tested these strategies in our recent randomized controlled trial and found it to be effective in
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41 483 improving adherence level among people with stroke.⁵⁰ Choosing the strategies from the
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43 484 framework can help in the pragmatic implementation in clinical practice or research trials. The
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45 485 framework is a useful guide for both clinicians and researchers to select appropriate strategies
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48 486 for enhancing exercise adherence.
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53 487 We did not include stroke survivors and caregivers in the Delphi panel which we
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55 488 consider a limitation of this study. However, the perceptions of stroke survivors were explored
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57 489 to develop the questionnaire for the first round.¹⁶ The representation of experts from each
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59 490 specialty was unequal which could have influenced the decision-making process that
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3 491 differentiated certain versus uncertain strategies. Hence, some of the strategies deemed
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5 492 uncertain may have clinical relevance for supporting adherence. Moreover, as the open-ended
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7 493 questionnaire was developed from the literature review and opinions of stroke survivors in the
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9 494 previous study, the experts did not get a chance to develop the initial themes.
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1819 **CONCLUSION**
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21
22 498 A set of strategies and a framework for enhancing adherence to home-based exercises
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24 499 after stroke has been developed and classified under nine domains: education on stroke and
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26 500 recovery, exercise prescription, feedback, and supervision, cognitive remediation, the
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28 501 involvement of family members, the involvement of society, promoting self-efficacy,
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30 502 motivational strategies, and reminder strategies. In countries where home-based exercises are
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32 503 the mainstay of rehabilitation, these strategies could reinforce self-management and facilitate
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34 504 adherence in the long term. Future studies should explore the experiences of stakeholders in
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36 505 implementing these strategies using qualitative methods. The set of strategies could be
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38 506 incorporated in a telerehabilitation model and cost-analysis could be performed in future.
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3 510 **Ethics statement**
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6 511 Institutional Ethics Committee, Kasturba Hospital, Manipal, India approved this study

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8 512 (IEC:355/2017)
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15 514 **Contributorship statement**
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18 515 The study was conceptualized by JMS and MN. AM, JMS, and MN developed the protocol

19 516 and designed the methodology. AM contacted the experts and prepared the 10-item

20 517 questionnaire. AD, DLM, GV, SP, STS, ArD, SDK, GN, HS, SKV, SK, BU and CE formed

21 518 the expert panel and contributed in the development of the framework. AM analysed the data

22 519 and prepared the first draft with supervision from JMS and MN. All authors have contributed

23 520 in drafting and revising the manuscript.
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36 522 **Competing Interest**
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39 523 None declared
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59 529 **Data sharing**
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3 530 No additional data available
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Figure Legend

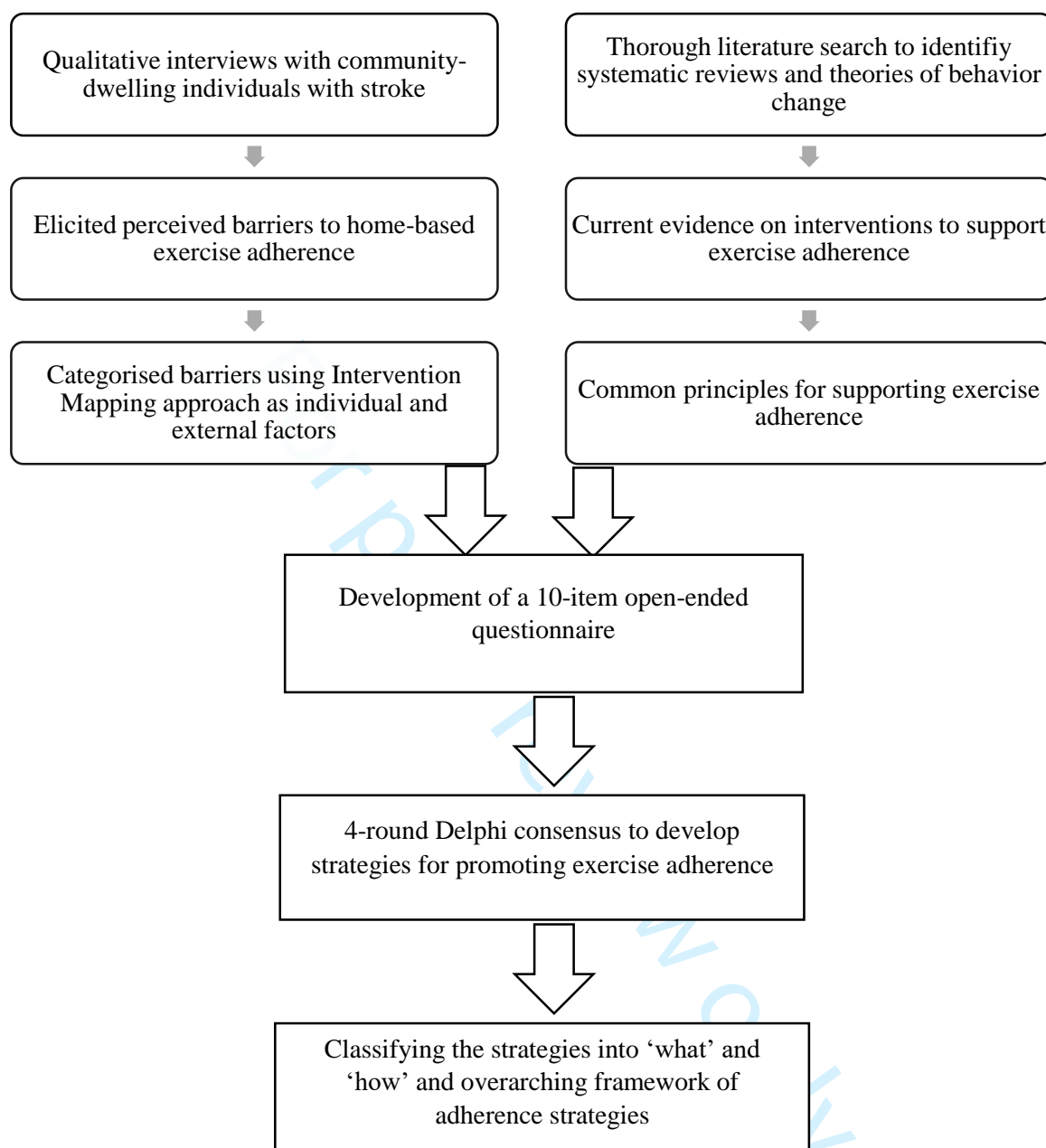
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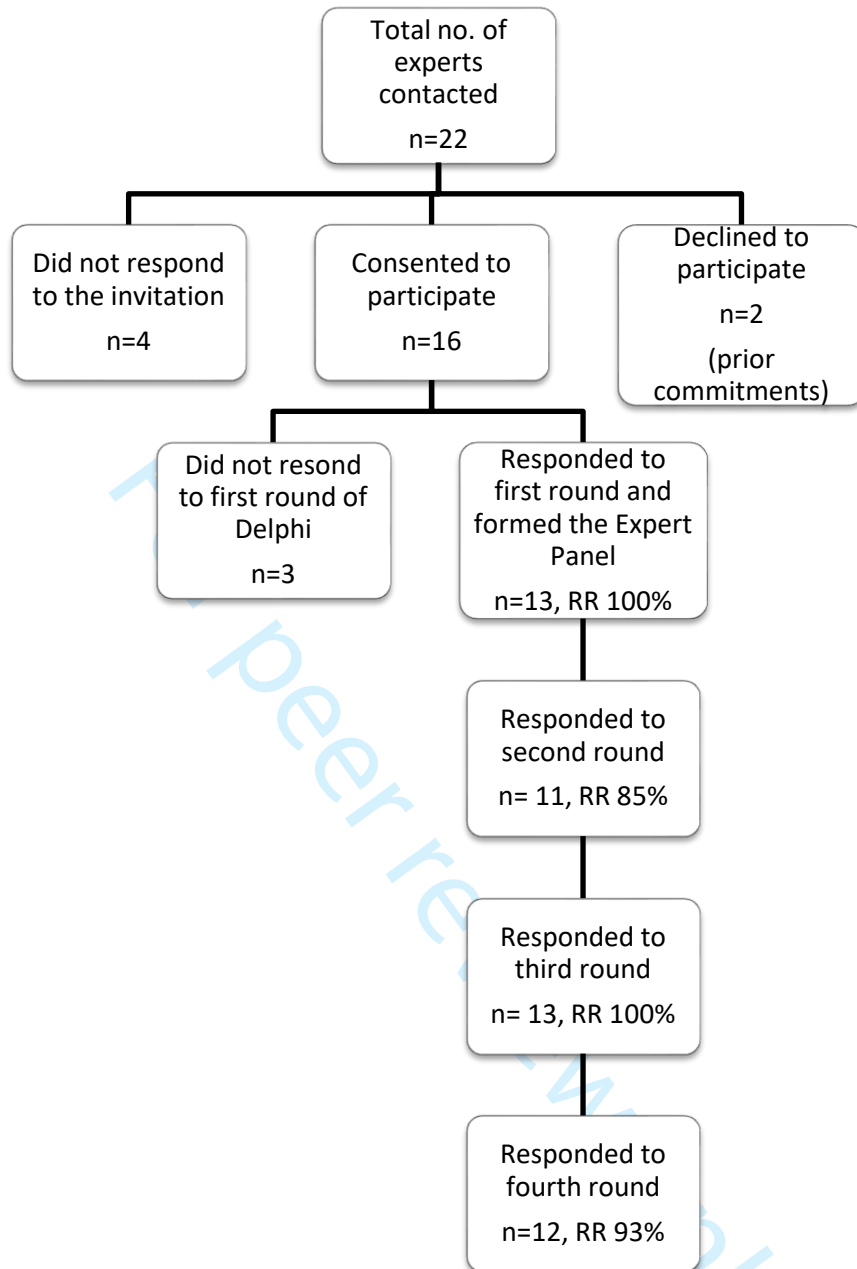
679 Figure 1: Process of development of adherence framework

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

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***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?

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

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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	<ul style="list-style-type: none"> • 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 <p>Education can be delivered via written information, group sessions, individual discussions, testimonials from recovered patients and caregivers, phone calls</p>	Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient, Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder

2	Exercise prescription	<ul style="list-style-type: none"> • 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 	<p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	Domain	Strategies	Healthcare provider	Stakeholder

3	Feedback and supervision	<ul style="list-style-type: none"> • 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 	<p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	Domain	Strategies	Healthcare provider	Stakeholder
4	Cognitive remediation	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p>	Patient, caregiver

	Domain	Strategies	Healthcare provider	Stakeholder
5	Involvement of the family members	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p>	Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder
6	Involvement of society	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke</p>	Community

		<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient

	Domain	Strategies	Healthcare provider	Stakeholder
8	Motivational strategies	<ul style="list-style-type: none"> 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. 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient

		<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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, Psychiatrist, 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

<p>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</p>	1/1-2
<p>Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions</p>	1/ 4-22

Introduction

<p>Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement</p>	3-4/48-76
<p>Purpose or research question - Purpose of the study and specific objectives or questions</p>	4/79-81

Methods

<p>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**</p>	5/101-103
<p>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</p>	5/107-109
<p>Context - Setting/site and salient contextual factors; rationale**</p>	NA
<p>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**</p>	5/93-99
<p>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</p>	4/85-86
<p>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**</p>	5/100-107

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3	Data collection instruments and technologies - Description of instruments (e.g.,	
4	interview guides, questionnaires) and devices (e.g., audio recorders) used for data	
5	collection; if/how the instrument(s) changed over the course of the study	6/125-129
6		
7	Units of study - Number and relevant characteristics of participants, documents,	
8	or events included in the study; level of participation (could be reported in results)	8/168-169
9		
10	Data processing - Methods for processing data prior to and during analysis,	
11	including transcription, data entry, data management and security, verification of	
12	data integrity, data coding, and anonymization/de-identification of excerpts	6/128-129
13		
14	Data analysis - Process by which inferences, themes, etc., were identified and	
15	developed, including the researchers involved in data analysis; usually references a	
16	specific paradigm or approach; rationale**	6/129-132
17		
18	Techniques to enhance trustworthiness - Techniques to enhance trustworthiness	
19	and credibility of data analysis (e.g., member checking, audit trail, triangulation);	
20	rationale**	7/149-151

Results/findings

23	Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and	
24	themes); might include development of a theory or model, or integration with	
25	prior research or theory	10-21/179-342
26		
27	Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts,	
28	photographs) to substantiate analytic findings	Supplementary
29		file 1

Discussion

32	Integration with prior work, implications, transferability, and contribution(s) to	
33	the field - Short summary of main findings; explanation of how findings and	
34	conclusions connect to, support, elaborate on, or challenge conclusions of earlier	
35	scholarship; discussion of scope of application/generalizability; identification of	
36	unique contribution(s) to scholarship in a discipline or field	21-23/350-408
37		
38	Limitations - Trustworthiness and limitations of findings	23-24/409-416
39		

Other

42	Conflicts of interest - Potential sources of influence or perceived influence on	
43	study conduct and conclusions; how these were managed	None
44		
45	Funding - Sources of funding and other support; role of funders in data collection,	
46	interpretation, and reporting	None
47		

*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.

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**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

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BMJ Open

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

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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

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1 **Development of strategies to support home-based exercise adherence after stroke in**
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5 **Low- and Middle-income Countries: A Delphi Consensus**
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63 **D. Keywords**

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2
3 81 **Abstract**
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5 82 **Objective:** To develop a set of strategies to enhance adherence to home-based exercises after
6
7 83 stroke, and an overarching framework to classify these strategies.
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10 84 **Method:** We conducted a four-round Delphi consensus (two online surveys, followed by a
11
12 85 focus group then a consensus round). The Delphi panel consisted of 13 experts from
13
14 86 Physiotherapy, Occupational Therapy, Clinical Psychology, Behavior Science, and
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16 87 Community Medicine. The experts were from India, Australia, and United Kingdom.
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20 88 **Results:** In round 1, a 10-item survey using open-ended questions was emailed to panel
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22 89 members and 75 strategies were generated. Of these, 25 strategies were included in round 2 for
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24 90 further consideration. A total of 64 strategies were finally included in the subsequent rounds.
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26 91 In round 3, the strategies were categorized into nine domains – i) patient education on stroke
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28 92 and recovery, ii) method of exercise prescription, iii) feedback and supervision, iv) cognitive
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30 93 remediation, v) involvement of family members, vi) involvement of society, vii) promoting
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32 94 self-efficacy, viii) motivational strategies and ix) reminder strategies. The consensus from 12
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34 95 experts (93%) led to the development of the framework in round 4.
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40 96 **Conclusion:** We developed a framework of comprehensive strategies to assist clinicians in
41
42 97 supporting exercise adherence among stroke survivors. It provides practical methods that can
43
44 98 be deployed in both research and clinical practices. Future studies should explore stakeholders'
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46 99 experiences and the cost effectiveness of implementing these strategies.
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59 104 **Strengths and limitations of this study**
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3 105 • The multidisciplinary expert panel consisted of specialists in exercise prescription,
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5 106 behavior science and community medicine, each having diverse experiences that
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7 107 contributed to the development of this multi-faceted framework of strategies
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10 108 • We developed strategies specific to low- and middle- income countries that are affordable
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12 109 and provide practical methods of implementation
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15 110 • One of the limitations of this study was that the individuals with stroke and their
16
17 111 caregivers were not included in the Delphi panel
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19 112 • There was an unequal representation of experts from different specialties
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124 INTRODUCTION

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

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

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3 147 Exercise adherence can be improved through motivational interventions, behavioral
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5 148 change strategies, multimedia, follow-up sessions, feedback, cognitive behavior therapy, skill
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8 149 training, self-monitoring, goal setting, coping strategies, and coaching.^{22,23,24} However, there is
9
10 150 limited information on how to practically incorporate these into clinical practice. Therefore,
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12 151 developing strategies for promoting post stroke exercise adherence is essential.^{12,15} Identifying
13
14 152 barriers affecting adherence to exercise, and developing strategies that can be practically
15
16 153 implemented by stroke survivors to modify those barriers, increases the potential for improving
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18 154 exercise adherence.²⁵ Thus, we aimed to develop a set of strategies to facilitate adherence to
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20 155 home-based exercises after stroke and a comprehensive framework to classify these strategies.
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31 158 **METHODS**

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34 159 We obtained approvals from the Institutional Research Committee and Institutional Ethics
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36 160 Committee (IEC:355/2017) of Kasturba Hospital, Manipal, India to conduct this study. This
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38 161 study was a part of a doctoral thesis which was conducted in four phases. In the first phase
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40 162 we measured level of exercise adherence among community living stroke survivors. In the
41
42 163 second phase, we conducted qualitative interviews with stroke survivors to understand the
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44 164 factors affecting exercise adherence. Based on the themes developed during qualitative study,
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46 165 we prepared a survey for use in this third phase which is a Delphi study. The fourth phase
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48 166 involved testing the effectiveness of developed framework of strategies in a pilot RCT.
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169 **Participant recruitment**

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3 170 Participants (experts) were recruited using purposive sampling. The criteria for selection were:
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5 171 i) expertise in stroke/ behavior change/ community health, ii) having more than ten years of
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7 172 clinical experience, iii) published in peer-reviewed journals, iv) involvement in translational
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9 173 and collaborative health research and v) employed in academia, research or clinical practice.
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13 174 We identified the experts through the collaborative network of the Centre for Comprehensive
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15 175 Stroke Rehabilitation and Research at the Manipal Academy of Higher Education. We aimed
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17 176 to recruit the majority of experts from India to ensure suggestions were context-specific to low-
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19 177 and middle-income countries. We invited experts to participate in the study from different
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21 178 fields (Physiotherapy, Occupational Therapy, Neurology, Clinical Psychology, Community
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23 179 Medicine, and Behavior Science) to ensure that the strategies were comprehensive and covered
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25 180 multiple aspects of adherence.
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30 181 Experts were invited via email. Those who agreed to participate gave their written
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32 182 consent and were included in the study. We conducted a four-round Delphi consensus; two
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34 183 online surveys, followed by a focus group to build a set of adherence strategies for home-based
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36 184 exercises based on survey results, then a final online consensus round.²⁶ Each round took two
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38 185 months. Experts were sent two reminder emails and any non-respondents were excluded from
39
40 186 that round. Except for the focus group, the experts were blinded to each other for all rounds,
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42 187 and responses were anonymous. The Delphi rounds were conducted between January 2018 and
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44 188 December 2018. The primary investigator, an experienced stroke physiotherapist (AM)
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46 189 collected and analyzed the data. The focus group was conducted by another investigator (JS)
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48 190 who has more than 15 years of experience in neurological rehabilitation and qualitative studies.
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193 **Data collection and analysis**

194 Round 1

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

209 We merged the experts' written responses to perform content analysis³⁵ and coded the
210 responses using Atlas.Ti8 software. The responses that were suggested by more than nine out
211 of 13 (70%) experts were considered as 'certain strategies.' Responses that were not common
212 and suggested by less than nine experts were labeled 'uncertain strategies' for further
213 consideration in round 2.

214 215 Round 2

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3 216 The second survey, consisting of only the ‘uncertain strategies’, was emailed to the expert
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6 217 panel, and they were asked to agree/disagree on the given strategies, and provide reasons for
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8 218 their opinion. For an ‘uncertain strategy’ to become a ‘certain strategy’ it needed to have a
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10 219 majority agreement, i.e., six out of 11 experts. This process resulted in a final set of 64
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12 220 strategies.

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18 222 Round 3

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21 223 We then conducted a face-to-face focus group to collate the included strategies into broader
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23 224 categories. The expert panel was asked to categorize the list of strategies into a specific domain.
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25 225 They also suggested practical ways of implementing the suggested strategies such as: who
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27 226 should design it, the content, how it should be delivered, and target stakeholders. Any experts
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29 227 who could not be present at the focus group were emailed the categories and asked to evaluate
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31 228 the draft framework.

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38 230 Round 4

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41 231 The framework of strategies was sent to all the experts for minor modifications and approval.
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43 232 The consensus from the experts led to the development of the final framework. Figure 1 shows
44
45 233 the development of the framework.

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50 51 52 53 235 **Patient and Public Involvement**

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56 236 The aim of the study was to provide guidance to facilitate adherence to home exercise
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58 237 programs. As a first step, it was felt important to understand patient experiences in exercise
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3 238 adherence. Towards this end, qualitative interviews were conducted among community-
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5 239 dwelling stroke survivors to explore their exercise behavior and barriers to exercise
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8 240 adherence in the second phase of this project. The patients' opinions highlighted that not only
9
10 241 patient-related factors but family, healthcare system, and community level factors played a
11
12 242 role in exercise non-adherence. This information was used in the development of open-ended
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14 243 questions that were included in the first round of the Delphi process. Therefore, the patients'
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16 244 perceptions and needs were incorporated in this study for designing adherence strategies and
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19 245 framework.
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29 248 **RESULTS**

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32 249 We invited 22 experts across India and abroad to participate in the Delphi survey. Thirteen
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34 250 consented to participate in the study and responded to round one (Figure 2). The final panel
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36 251 consisted of physiotherapists (n=7), clinical psychologists (n=3), occupational therapist (n=1),
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38 252 behavior scientist (n=1), and epidemiologist (n=1). Three experts were from Australia, one
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40 253 from the UK, and the remaining experts were from India. Each panel member had more than
41
42 254 ten years of clinical experience and multiple publications. (Table 1)
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256 **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

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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).

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

Items	Domains	Strategies
1	Patient education on stroke and recovery	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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

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4		<ul style="list-style-type: none">• Regular monitoring
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6		<ul style="list-style-type: none">• Understand previous exposure with exercises
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8	4	Cognitive remediation
9		<ul style="list-style-type: none">• Educating on the benefits of exercise
10		<ul style="list-style-type: none">• Motivational interviewing
11		<ul style="list-style-type: none">• Cognitive Behavior Therapy techniques
12		
13		<ul style="list-style-type: none">• Behavioral activation
14		
15		<ul style="list-style-type: none">• Contingency charts
16		
17		<ul style="list-style-type: none">• Involving group sessions
18		
19		<ul style="list-style-type: none">• Meaningful tasks
20		
21		<ul style="list-style-type: none">• Psycho education
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5	Involvement of family members	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Involvement of friends • Involving group sessions • Modeling behavior • Support and exercise groups • Social comparison
7	Promoting self-efficacy	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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

		<ul style="list-style-type: none">• Devise color bands (coded for level of recovery)• Intra-group competition• Avoid direct comparison
9	9 Reminders strategies	<ul style="list-style-type: none">• 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

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3 **285 Round 4**
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6 286 The final framework of strategies for improving home-based exercise adherence was agreed
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8 287 upon by 12 (93% response rate) experts. The experts agreed that the exercise-related strategies
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10 288 should be designed and delivered by therapists having experience in stroke care such as an
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12 289 occupational therapist, physiotherapist, physiatrist, or stroke nurse. They suggested that the
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14 290 strategies requiring behavioral techniques should be designed and supervised by a licensed
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16 291 clinical psychologist or behavior therapist. In the following section, we have highlighted the
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18 292 key suggestions from the expert committee under each domain. The details of the framework
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20 293 are provided in supplementary file 3.
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29 295 Strategies for improving adherence to home-based exercises post-stroke under each domain
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32 296 *Domain I – Patient education on stroke and recovery*
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35 297 Experts agreed that the patient education should comprise of – i) usual time course and speed
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37 298 of recovery, ii) the impact of practice and exercise on recovery, iii) adverse effects of rest and
38
39 299 positive effects of activity, iv) the importance of secondary risk factor management, v)
40
41 300 managing complications (e.g., spasticity, pain, fatigue, contracture, depression), vi) alternative
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43 301 medicine (including traditional medicines and religious practices), vii) importance of adhering
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45 302 to the exercise program, dosage of the exercise program, viii) role of a caregiver, ix) recovery
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47 303 and return (interaction between severity and prognosis), x) proper positioning techniques, and
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49 304 xi) misconceptions about stroke recovery.
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54 305 Methods recommended for delivering education included: written information,
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56 306 individual discussions, and phone calls that are individually tailored to each patient's needs,
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3 307 as well as conducting group sessions wherein testimonials from recovered patients and their
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5 308 caregivers are presented.
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11 310 *Domain II – Methods of exercise prescription*
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14 311 Exercises that are prescribed should be task-specific and individually tailored based on each
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16 312 persons' impairments, goals, and context. These exercises should be reinforced using
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18 313 demonstration and practice. Exercise prescription should include personalized information or
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21 314 messages of personal encouragement.
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24 315 Additional ways for prescribing exercises may include written or pictorial instructions,
25
26 316 videos of exercises, voice-assisted programs, or internet-based applications. Other ways that
27
28 317 can support adherence are video recording of patients' exercise performance, splitting the
29
30 318 exercise into smaller steps for severe impairments, and gradually increasing difficulty level.
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33 319 Gaming or gamification may also facilitate exercise adherence since it gives a sense of
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35 320 achievement and reinforces exercise behavior.
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42 322 *Domain III - Feedback and supervision*
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45 323 For regular feedback and supervision, maintaining an exercise log, everyday activity status,
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47 324 or updates that are monitored by the medical team could be useful for supporting adherence.
48
49 325 Having therapists clear any doubt that patients might have about their exercise prescription,
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51 326 routinely ask patients about their progress, and periodically ask patients to give feedback about
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53
54 327 the quality of their interaction with therapists will provide a sense of supervision and
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56 328 accountability, thus facilitating adherence.
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3 329 There should be regular contact with the therapists (in person or via telehealth.)
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5 330 Therapists can use recorded audio/video clips, individual or group discussions for feedback
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7 331 and supervision. Therapists should use standardized assessments to measure clinical outcomes
8
9 332 and provide feedback on progress.
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16 334 *Domain IV - Cognitive remediation*

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19 335 The experts in behavioral science and cognitive rehabilitation agreed on prescribing tasks that
20
21 336 are focused on functional recovery, planning the exercise centered on individual goals, and
22
23 337 understanding the patient's motivation before the treatment session. Motivational interviewing
24
25 338 or Motivation Enhancement Therapy could be used to understand their baseline motivational
26
27 339 level and establish intrinsic motivation for behavior change. Providing positive feedback and
28
29 340 reinforcement for small improvements engenders confidence in patients. Additionally, having
30
31 341 a contingency plan for days when exercises could not be performed would prevent abrupt
32
33 342 cessation of exercise routine. Using behavioral activation (a treatment technique used in
34
35 343 clinical psychology for managing depression) so that patients perform one enjoyable activity
36
37 344 each day would keep them motivated to stick to their exercise schedule.
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46 346 *Domain V - Involvement of the family members*

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49 347 Experts suggested that the family should be involved; however, the amount of assistance
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51 348 provided by the family needs to be balanced so as not to promote dependency. Assessing
52
53 349 knowledge and understanding of the caregivers on post-stroke exercises is crucial for them to
54
55 350 reinforce patients' adherence. Family can be involved by being the patient's exercise partners,
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57 351 or by setting up exercise reminders, or by helping track the patient's progress. Demonstrating
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3 352 and practicing exercises with family can also enhance the self-efficacy and confidence of
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5 353 caregivers.

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8 354 Managing the expressed emotions of the family members is important as it may hinder
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10 355 treatment and restrict the patient's autonomy. Rotating family members in the supervision of
11
12 356 the patient's activities can help in reducing burnout and maintain novelty in routine.

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18 358 *Domain VI - Involvement of society/ community*

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21 359 Family and friends can interact with the patient on topics not concerning the illness (areas of
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23 360 interest to the patient such as work/ politics/ current affairs/ sports.) Some strategies for
24
25 361 involving society include having weekly phone/face-to-face interactions with colleagues,
26
27 362 family, and friends, or joining/ creating support groups or associations of families with stroke.
28
29 363 Testimonials of recovered patients and their experiences with rehabilitation can be used for
30
31 364 motivating other patients. Additional ways to include community are awareness programs for
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33 365 healthy adults, local group exercise for people with stroke, and peer support or exercise
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35 366 buddies.

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41 368 *Domain VII - Promoting self-efficacy*

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44 369 Experts suggested using evidence-based behavior change strategies (e.g., the Capacity
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46 370 Opportunity Motivation-Behavior model³⁶, or Intervention Mapping approach²⁵) and using
47
48 371 rehabilitation principles of substitution and optimization. Some suggested strategies to promote
49
50 372 self-efficacy include

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57 373
 - Collaborating with patients to devise the best monitoring strategy for them such as

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59 374 exercise practice sheets, paper, electronic diary, or internet-based applications.

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3 375 • Providing continual support after the termination of the formal therapy program.
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6 376 • Providing personal graph charts of success that can be generated weekly or monthly.
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8 377 • Ensuring an adequate number of activities in which the patient can engage
9
10 378 independently or with minimal supervision.
11
12 379 • Identifying anchors in the day (sleep times/meals/activities - exercise, recreation,
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14 380 social) and setting a general intention of sticking to their exercise program, or
15
16 381 developing contingency "if/then" plans.
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18 382 • Discuss and explore potential barriers that would impede or hinder exercise sessions
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20 383 with patients.
21
22 384 • Overcome barriers using pie-charts, pros versus cons analysis/ identification of
23
24 385 cognitive distortions/ downward arrow techniques/ developing a life brochure/
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26 386 movement, or art-based therapeutic activities.
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28 387 • Motivation interviewing to help to elicit patients' intention to adhere to exercises and
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30 388 understand their motivation level.
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390 *Domain VIII - Motivational strategies*

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

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

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3 399 • Using productivity monitoring tools to keep them motivated.
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5
6 400 • Maintaining a daily log for positive feelings or gratitude journal, and telephone follow-
7
8 401 up where the medical team provides words of encouragement can promote adherence.
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10 402 • Having video feedback at regular intervals, setting progressive but attainable targets,
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12 403 and involving patients in goal setting may motivate patients to continue exercising.
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14
15 404 • Devising wrist bands of different color (coded for level of recovery and mastery of
16
17 405 tasks)
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19
20 406 • Giving t-shirts or wrist bands of that color and upgrading as they progress to encourage
21
22 407 regular exercising.
23
24 408 • Competitions during group sessions among people with similar impairments and
25
26 409 provide tokens or badges for improvement that can be exchanged for tangible rewards
27
28 410 to make exercising fun and interesting.
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31 411 • Having an interactive internet-based community where people can add friends to
32
33 412 motivate each other to exercise can also be a solution in times of social distancing.
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40 414 *Domain IX - Reminders strategies*
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43 415 Experts agreed on reminder strategies including:
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- 46 416 • Calling patients regularly and visiting them weekly or fortnightly.
47
48 417 • Using sticky notes in the patients' homes, tally sheets, pamphlets, or SMS/WhatsApp
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50 418 reminders.
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53 419 • Therapists can show exercise videos so that patients can accurately remember each
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55 420 exercise steps and use the same video for home practice.
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3 421 • Use of technology such as sending small feedback surveys, disease information,
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5 422 scientific literature, and progress cards to keep the patients engaged and motivated to
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7 423 continue exercises.
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10 424 • Using daily logs (electronic or paper-pencil) and weekly reviewing of the exercise log
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12 425 to help stick to a schedule.
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17 18 427 **DISCUSSION**

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21 428 We aimed to develop a comprehensive set of clinically applicable strategies for
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23 429 optimizing adherence to home-based exercises after a stroke. In a Delphi method, experts from
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25 430 different fields co-construct knowledge and provide recommendations on a particular topic.³⁷
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27 431 In our study, we incorporated knowledge from experts in exercise science, behavior science,
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29 432 and experts experienced in community care to develop the set of strategies.
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34 433 The 10-item open-ended survey, used in the first round, was based on our qualitative
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36 434 study¹⁶ that explored factors influencing adherence among stroke survivors using the
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38 435 Intervention Mapping approach,³⁸ which is underpinned by the Socio-Ecological Model.³⁹ Our
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40 436 framework is constructed on the Socio-Ecological Model of behavior change. Since there is
41
42 437 limited access to healthcare facilities, higher cost of clinic-based rehabilitation, and lack of
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44 438 transport to hospital setup in low- and middle-income countries, home-based exercise
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46 439 adherence becomes crucial for recovery. The developed adherence strategies are applicable for
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48 440 low- and middle-income countries and could be influential for the success of home-based
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50 441 rehabilitation in the long term.
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55 442 The suggested strategies were categorized into nine domains, which were in line with
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57 443 the findings in existing systematic reviews.^{22, 40, 41, 42} The included studies reported behavior
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3 444 strategies and theories such as self-efficacy,²² motivational interventions,⁴⁰ social-cognitive
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5 445 theory,⁴¹ activity-monitoring, feedback system, goal-setting,⁴² self-regulated exercises,⁴³ for
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7 446 improving adherence. However, none of the studies had used Delphi approaches and provided
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10 447 broad concepts for enhancing exercise adherence without providing specific context, culture,
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12 448 or techniques for delivering the interventions.

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15 449 Adherence is affected by multiple factors such as age, self-efficacy, caregiver support,
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17 450 previous exercise behavior, the severity of stroke, and stages of stroke recovery.^{19,20,21,44,45}
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19 451 Therefore, the framework of strategies provides the opportunity to individualize the strategies
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21 452 based on each person's impairments, recovery, the severity of stroke, and available support
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23 453 system. The exercises can be tailored depending on the abilities and context of each person.
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28 454 Adherence to post-stroke rehabilitation is a dynamic process and changes with each
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30 455 stage of recovery, characterized by a higher adherence rate during the initial period of recovery
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32 456 followed by a slow decrease in adherence rate and a stable phase where adherence does not
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34 457 change much.⁴⁶ Some strategies such as enhancing self-efficacy, activity scheduling, regular
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36 458 feedback, and monitoring can be initiated during the early phase while strategies such as
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38 459 interim progress tracking, personal graphs, involvement of peer group, gamification of
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40 460 exercises, providing rewards, and reminders can be started gradually to break the monotony of
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42 461 ongoing exercise programs and encourage adherence. Therefore, implementing these
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44 462 adherence strategies early in rehabilitation can be beneficial for maintaining adherent behavior
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46 463 in the long term. The results from a meta-analysis of mixed disease populations demonstrated
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48 464 that adherence is low when perceived disease severity is high among patients with serious
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50 465 illnesses.⁴⁷ However, future studies are needed to establish the effects of stroke severity on
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52 466 exercise adherence.
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3 467 The different sets of strategies within the framework can be deployed to improve
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5 468 exercise adherence after stroke. The framework is useful for stroke survivors, caregivers, and
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7 469 healthcare providers as it offers adherence techniques at a personal, interpersonal, and
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9 470 organizational level. It gives clear recommendations on each strategy's content, different ways
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11 471 of delivering it, healthcare professionals who should design it, and on who might benefit from
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13 472 those strategies.
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18 473 The uncertain strategies that were not agreed upon by the experts included participating
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20 474 in social events, regular checks by neighbors or games/competition with family/caregivers.
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22 475 Such strategies may improve the social interaction but may not be feasible due to the caregiver's
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24 476 burden after stroke,⁴⁸ and family members may not find adequate time for such activities. Other
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26 477 uncertain strategies such as virtual reality, circuit training, or award function were excluded
27
28 478 due to the cost, training, and equipment required.¹⁶ Strategies such as educating patients on the
29
30 479 location and types of stroke and educational movies were considered redundant for improving
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32 480 exercise adherence.⁴⁹ Although social media such as Whatsapp was agreed upon by the experts
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34 481 as a mode of reminder, Whatsapp groups were not preferred as a strategy due to fear of
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36 482 dissemination of inaccurate information among the participants and compromising the privacy
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38 483 of health information.
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44 484 The key strength of this study lies in the multidisciplinary nature of the expert panel
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46 485 that was recruited, which included specialists in exercise prescription, experts in behavior, and
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48 486 community experts having diverse experiences that contributed to developing a multi-faceted
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50 487 framework of strategies. Due to the pandemic that has compromised clinic-based rehabilitation
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52 488 worldwide, these strategies can be delivered in any healthcare setting, are easy to implement,
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54 489 affordable, and offer a comprehensive set of strategies to facilitate exercise adherence. We have
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56 490 tested the framework of strategies in a recent randomized controlled trial and found it to be
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58 491 effective in improving adherence level among people with stroke.⁵⁰ Choosing the strategies
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3 492 from the framework can help in the pragmatic implementation in clinical practice or research
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5 493 trials. The framework is a useful guide for both clinicians and researchers to select appropriate
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8 494 strategies for enhancing exercise adherence.
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11 495 We did not include stroke survivors and caregivers in the Delphi panel which we
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13 496 consider a limitation of this study. However, the perceptions of stroke survivors were explored
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15 497 to develop the questionnaire for the first round.¹⁶ The representation of experts from each
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17 498 specialty was unequal which could have influenced the decision-making process that
18
19 499 differentiated certain versus uncertain strategies. Hence, some of the strategies deemed
20
21 500 uncertain may have clinical relevance for supporting adherence. Moreover, as the open-ended
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23 501 questionnaire was developed from the literature review and opinions of stroke survivors in the
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25 502 previous study, the experts did not get a chance to develop the initial themes.
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32 33 34 35 36 505 **CONCLUSION**

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39 506 A set of strategies and a framework for enhancing adherence to home-based exercises
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41 507 after stroke has been developed and classified under nine domains: patient education on
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43 508 stroke and recovery, exercise prescription, feedback, and supervision, cognitive remediation,
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45 509 the involvement of family members, the involvement of society, promoting self-efficacy,
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47 510 motivational strategies, and reminder strategies. In countries where home-based exercises are
48
49 511 the mainstay of rehabilitation, these strategies could reinforce self-management and facilitate
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51 512 adherence in the long term. Future studies should explore the experiences of stakeholders in
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53 513 implementing these strategies using qualitative methods. The set of strategies could be
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55 514 incorporated in a telerehabilitation model and cost-analysis could be performed in future.
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For peer review only

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3 **518 Ethics statement**
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6 519 Institutional Ethics Committee, Kasturba Hospital, Manipal, India approved this study
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8 (IEC:355/2017)
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15 **522 Contributorship statement**
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18 523 The study was conceptualized by JMS and MN. AM, JMS, and MN developed the protocol
19
20 524 and designed the methodology. AM contacted the experts and prepared the 10-item
21
22
23 525 questionnaire. AD, DLM, GV, SP, STS, ArD, SDK, GN, HS, SKV, SK, BU and CE formed
24
25 526 the expert panel and contributed in the development of the framework. AM analysed the data
26
27 527 and prepared the first draft with supervision from JMS and MN. All authors have contributed
28
29
30 528 in drafting and revising the manuscript.
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36 **530 Competing Interest**
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46
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57 **537 Data sharing**
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538 No additional data available

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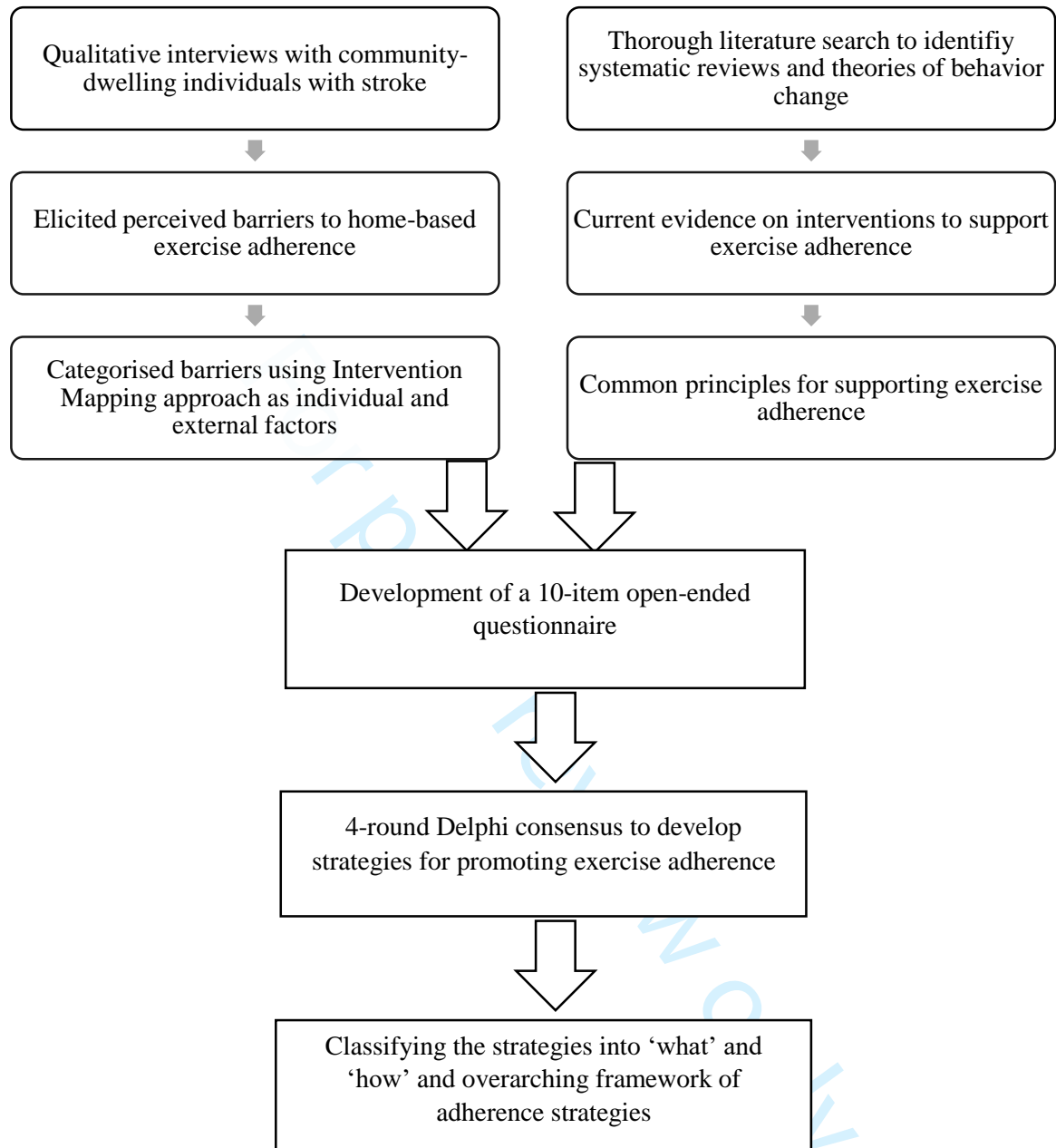
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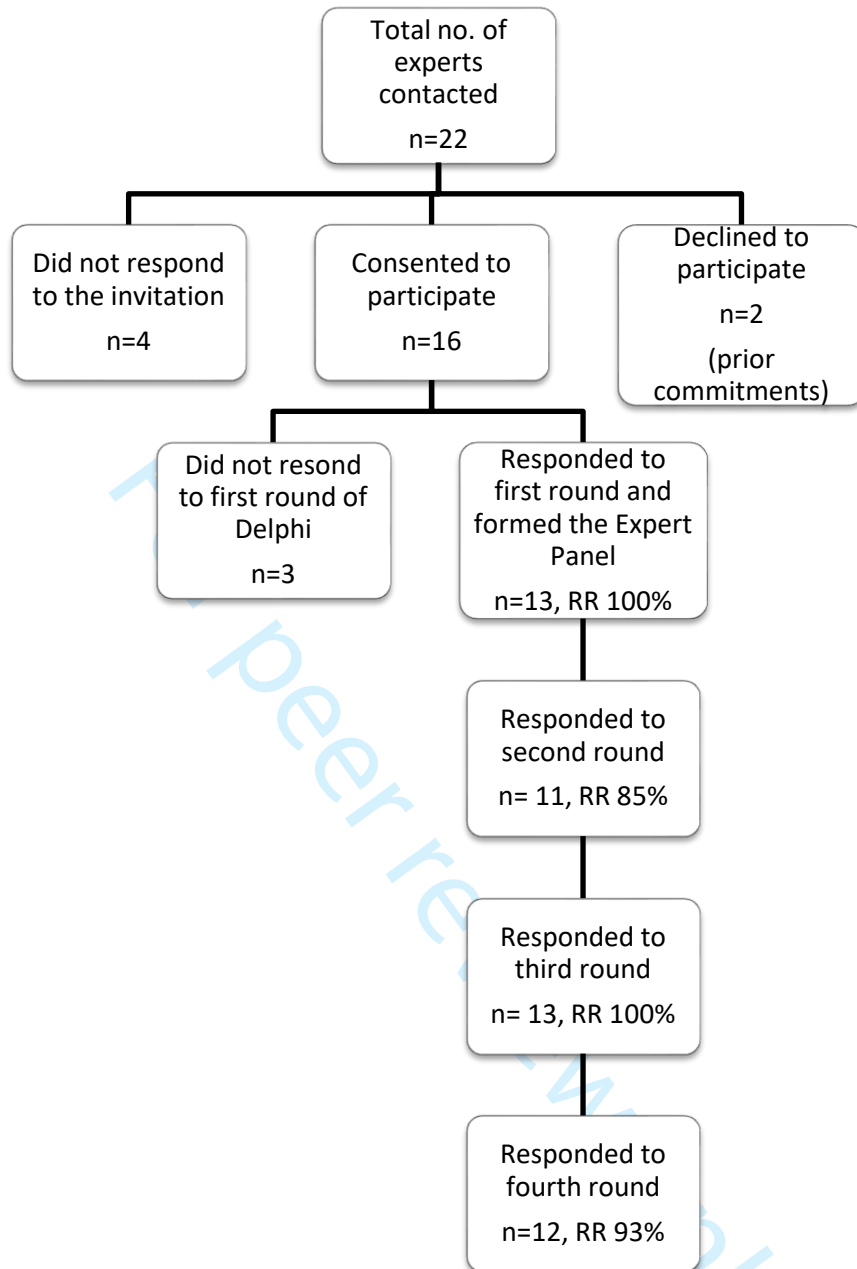
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6 687 Figure 1: Process of development of adherence framework7
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For peer review only





***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?

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

For peer review only

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	<ul style="list-style-type: none"> • 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 <p>Education can be delivered via written information, group sessions, individual discussions, testimonials from recovered patients and caregivers, phone calls</p>	Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient, Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder

2	Exercise prescription	<ul style="list-style-type: none"> • 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 	<p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	Domain	Strategies	Healthcare provider	Stakeholder

3	Feedback and supervision	<ul style="list-style-type: none"> • 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 	<p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	Domain	Strategies	Healthcare provider	Stakeholder
4	Cognitive remediation	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p>	Patient, caregiver

	Domain	Strategies	Healthcare provider	Stakeholder
5	Involvement of the family members	<ul style="list-style-type: none"> 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p>	Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder
6	Involvement of society	<ul style="list-style-type: none"> 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke</p>	Community

		<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient

	Domain	Strategies	Healthcare provider	Stakeholder
8	Motivational strategies	<ul style="list-style-type: none"> 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. 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p>	Patient

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		<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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, Psychiatrist, Stroke nurse)	Patient, caregiver

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

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63 **D. Keywords**

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For peer review only

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3 81 **Abstract**
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5 82 **Objective:** To develop a set of strategies to enhance adherence to home-based exercises after
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7 83 stroke, and an overarching framework to classify these strategies.
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10 84 **Method:** We conducted a four-round Delphi consensus (two online surveys, followed by a
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12 85 focus group then a consensus round). The Delphi panel consisted of 13 experts from
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14 86 Physiotherapy, Occupational Therapy, Clinical Psychology, Behavior Science, and
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16 87 Community Medicine. The experts were from India, Australia, and United Kingdom.
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20 88 **Results:** In round 1, a 10-item survey using open-ended questions was emailed to panel
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22 89 members and 75 strategies were generated. Of these, 25 strategies were included in round 2 for
23
24 90 further consideration. A total of 64 strategies were finally included in the subsequent rounds.
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26 91 In round 3, the strategies were categorized into nine domains – i) patient education on stroke
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28 92 and recovery, ii) method of exercise prescription, iii) feedback and supervision, iv) cognitive
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30 93 remediation, v) involvement of family members, vi) involvement of society, vii) promoting
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32 94 self-efficacy, viii) motivational strategies and ix) reminder strategies. The consensus from 12
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34 95 experts (93%) led to the development of the framework in round 4.
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40 96 **Conclusion:** We developed a framework of comprehensive strategies to assist clinicians in
41
42 97 supporting exercise adherence among stroke survivors. It provides practical methods that can
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44 98 be deployed in both research and clinical practices. Future studies should explore stakeholders'
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46 99 experiences and the cost-effectiveness of implementing these strategies.
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3 105 **Strengths and limitations of this study**
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- 5 106 • The multidisciplinary expert panel consisted of specialists in exercise prescription,
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7 behavior science, and community medicine, each having diverse experiences that
8 107
9 contributed to the development of this multi-faceted framework of strategies
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12 109 • We developed strategies specific to low- and middle-income countries that are affordable
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14 and provide practical methods of implementation
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17 111 • One of the limitations of this study was that the individuals with stroke and their
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19 caregivers were not included in the Delphi panel
20 112
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22 113 • There was an unequal representation of experts from different specialties
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125 INTRODUCTION

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

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

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3 148 Exercise adherence can be improved through motivational interventions, behavioral
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5 149 change strategies, multimedia, follow-up sessions, feedback, cognitive behavior therapy, skill
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8 150 training, self-monitoring, goal setting, coping strategies, and coaching.^{21,22,23} However, there is
9
10 151 limited information on how to practically incorporate these into clinical practice. Therefore,
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12 152 developing strategies for promoting post-stroke exercise adherence is essential.^{12,24} Identifying
13
14 153 barriers affecting adherence to exercise, and developing strategies that can be practically
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16 154 implemented by stroke survivors to modify those barriers, increases the potential for improving
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18 155 exercise adherence.²⁵ Thus, we aimed to develop a set of strategies to facilitate adherence to
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20 156 home-based exercises after stroke and a comprehensive framework to classify these strategies.
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31 159 **METHODS**

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34 160 We obtained approvals from the Institutional Research Committee and Institutional Ethics
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36 161 Committee (IEC:355/2017) of Kasturba Hospital, Manipal, India to conduct this study. This
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38 162 study was a part of a doctoral thesis that was conducted in four phases. In the first phase, we
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40 163 measured the level of exercise adherence among community-living stroke survivors. In the
41
42 164 second phase, we conducted qualitative interviews with stroke survivors to understand the
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44 165 factors affecting exercise adherence. Using the themes derived in the second phase, a Delphi
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46 166 study was conducted in the third phase to develop a framework of strategies to support
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48 167 adherence to the home exercise program. The fourth phase involved testing the effectiveness
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50 168 of the developed framework of strategies in a pilot randomized controlled trial. The methods
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52 169 and findings of Phases I, II, and IV are published elsewhere.^{14,15,26} The current study (Delphi
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54 170 consensus) describes the process and findings of the third phase of the project.
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9 **173 Participant recruitment**10
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12 174 Participants (experts) were recruited using purposive sampling. The criteria for selection were:13
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15 175 i) expertise in stroke/ behavior change/ community health, ii) having more than ten years of
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17 176 clinical experience, iii) published in peer-reviewed journals, iv) involvement in translational
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19 177 and collaborative health research, and v) employed in academia, research, or clinical practice.20
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22 178 We identified the experts through the collaborative network of the Centre for Comprehensive
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24 179 Stroke Rehabilitation and Research at the Manipal Academy of Higher Education. We aimed
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26 180 to recruit a majority of experts from India to ensure suggestions were context-specific to low-
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28 181 and middle-income countries. We invited experts to participate in the study from different
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30 182 fields (Physiotherapy, Occupational Therapy, Neurology, Clinical Psychology, Community
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32 183 Medicine, and Behavior Science) to ensure that the strategies were comprehensive and covered
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34 184 multiple aspects of adherence.35
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39 185 Experts were invited via email. Those who agreed to participate gave their written
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41 186 consent and were included in the study. We conducted a four-round Delphi consensus; two
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43 187 online surveys, followed by a focus group to build a set of adherence strategies for home-based
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45 188 exercises based on survey results, then a final online consensus round.²⁷ Each round took two
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47 189 months. Experts were sent two reminder emails and any non-respondents were excluded from
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49 190 that round. Except for the focus group, the experts were blinded to each other for all rounds,
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51 191 and responses were anonymous. The Delphi rounds were conducted between January 2018 and
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55 192 December 2018. The primary investigator, an experienced stroke physiotherapist (AM)

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3 193 collected and analyzed the data. The focus group was conducted by another investigator (JS)
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5 194 who has more than 15 years of experience in neurological rehabilitation and qualitative studies.
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15 197 **Data collection and analysis**

17 18 198 Round 1

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21 199 Our previous study explored factors influencing adherence to home-based exercises among
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23 200 stroke survivors through in-depth interviews.¹⁵ Using this information, we categorized the
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25 201 barriers reported by the stroke survivors into internal and external factors using the Intervention
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27 202 Mapping approach.²⁵ We also performed a literature search in PubMed, Scopus, Web of
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29 203 Science, and Cochrane using the search terms "physical exercises," "adherence," "compliance,"
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31 204 "behavior change," and "health behavior." We reviewed studies from the bibliographies of the
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33 205 relevant articles. We identified health behavior change theories and existing
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35 206 strategies/interventions used for improving adherence to long-term therapies. Our review of
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37 207 the literature identified common principles for supporting adherence such as motivation, self-
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39 208 efficacy, social support, the role of family, online health support (mHealth), and behavior
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41 209 change techniques.^{27,28,29,30,31,32,33,34} Our findings from the literature and our qualitative study
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43 210 were combined to form a 10-item survey using open-ended questions in SurveyMonkey
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45 211 software (<https://www.surveymonkey.com/>). The survey was then emailed to the expert panel
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47 212 (Supplementary file 1).
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54 213 We merged the experts' written responses to perform content analysis³⁵ and coded the
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56 214 responses using ATLAS.ti 8 software. The responses that were suggested by more than nine
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58 215 out of 13 (70%) experts were considered as 'certain strategies.' Responses that were not
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3 216 common and suggested by less than nine experts were labeled 'uncertain strategies' for further
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5 217 consideration in round 2.
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12 219 Round 2

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15 220 The second survey, consisting of only the 'uncertain strategies', was emailed to the expert
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17 221 panel, and they were asked to agree/disagree on the given strategies, and provide reasons for
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19 222 their opinion. For an 'uncertain strategy' to become a 'certain strategy' it needed to have a
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21 223 majority agreement, i.e., six out of 11 experts. This process resulted in a final set of 64
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23 224 strategies.
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30 226 Round 3

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33 227 We then conducted a face-to-face focus group to collate the included strategies into broader
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35 228 categories. The expert panel was asked to categorize the list of strategies into a specific domain.
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37 229 They also suggested practical ways of implementing the suggested strategies such as: who
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39 230 should design it, the content, how it should be delivered, and target stakeholders. Any experts
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41 231 who could not be present at the focus group were emailed the categories and asked to evaluate
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43 232 the draft framework.
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51 234 Round 4

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54 235 The framework of strategies was sent to all the experts for minor modifications and approval.
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56 236 The consensus from the experts led to the development of the final framework. Figure 1 shows
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58 237 the development of the framework.
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239 **Patient and Public Involvement**

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

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251 **RESULTS**

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

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259 **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

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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).

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

Items	Domains	Strategies
1	Patient education on stroke and recovery	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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

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4		<ul style="list-style-type: none">• Regular contact with therapists
5		<ul style="list-style-type: none">• Recording exercises for feedback
6		<ul style="list-style-type: none">• Regular monitoring
7		<ul style="list-style-type: none">• Understand previous exposure with exercises
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11	4	Cognitive remediation
12		<ul style="list-style-type: none">• Educating on the benefits of exercise
13		<ul style="list-style-type: none">• Motivational interviewing
14		<ul style="list-style-type: none">• Cognitive Behavior Therapy techniques
15		<ul style="list-style-type: none">• Behavioral activation
16		<ul style="list-style-type: none">• Contingency charts
17		<ul style="list-style-type: none">• Involving group sessions
18		<ul style="list-style-type: none">• Meaningful tasks
19		<ul style="list-style-type: none">• Psycho education
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5	Involvement of family members	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Involvement of friends • Involving group sessions • Modeling behavior • Support and exercise groups • Social comparison
7	Promoting self-efficacy	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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

		<ul style="list-style-type: none">• Devise color bands (coded for level of recovery)• Intra-group competition• Avoid direct comparison
9	Reminders strategies	<ul style="list-style-type: none">• 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

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3 289 **Round 4**
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6 290 The final framework of strategies for improving home-based exercise adherence was agreed
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8 291 upon by 12 (93% response rate) experts. The experts agreed that the exercise-related strategies
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10 292 should be designed and delivered by therapists having experience in stroke care such as an
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12 293 occupational therapist, physiotherapist, physiatrist, or stroke nurse. They suggested that the
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14 294 strategies requiring behavioral techniques should be designed and supervised by a licensed
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16 295 clinical psychologist or behavior therapist. In the following section, we have highlighted the
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18 296 key suggestions from the expert committee under each domain. The details of the framework
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20 297 are provided in supplementary file 3.
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29 299 Strategies for improving adherence to home-based exercises post-stroke under each domain
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32 300 *Domain I – Patient education on stroke and recovery*
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35 301 Experts agreed that the patient education should comprise of: i) usual time course and speed of
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37 302 recovery, ii) the impact of practice and exercise on recovery, iii) adverse effects of rest and
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39 303 positive effects of activity, iv) the importance of secondary risk factor management, v)
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41 304 managing complications (e.g., spasticity, pain, fatigue, contracture, depression), vi) alternative
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43 305 medicine (including traditional medicines and religious practices), vii) importance of adhering
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45 306 to the exercise program, dosage of the exercise program, viii) role of a caregiver, ix) recovery
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47 307 and return (interaction between severity and prognosis), x) proper positioning techniques, and
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49 308 xi) misconceptions about stroke recovery.
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54 309 Methods recommended for delivering education included: written information,
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56 310 individual discussions, and phone calls that are individually tailored to each patient's needs,
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3 311 as well as conducting group sessions wherein testimonials from recovered patients and their
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5 312 caregivers are presented.
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11 314 *Domain II – Methods of exercise prescription*
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14 315 Exercises that are prescribed should be task-specific and individually tailored based on each
15
16 316 persons' impairments, goals, and context. These exercises should be reinforced using
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18 317 demonstration and practice. Exercise prescription should include personalized information or
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21 318 messages of personal encouragement.
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24 319 Additional ways for prescribing exercises may include written or pictorial instructions,
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26 320 videos of exercises, voice-assisted programs, or internet-based applications. Other ways that
27
28 321 can support adherence are video recording of patients' exercise performance, splitting the
29
30 322 exercise into smaller steps for severe impairments, and gradually increasing difficulty level.
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33 323 Gaming or gamification may also facilitate exercise adherence since it gives a sense of
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35 324 achievement and reinforces exercise behavior.
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42 326 *Domain III - Feedback and supervision*
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45 327 For regular feedback and supervision, maintaining an exercise log, everyday activity status,
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47 328 or updates that are monitored by the medical team could be useful for supporting adherence.
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49 329 Having therapists clear any doubt that patients might have about their exercise prescription,
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52 330 routinely ask patients about their progress, and periodically ask patients to give feedback about
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54 331 the quality of their interaction with therapists will provide a sense of supervision and
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56 332 accountability, thus facilitating adherence.
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3 333 There should be regular contact with the therapists (in person or via telehealth.)
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5 334 Therapists can use recorded audio/video clips, individual or group discussions for feedback
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8 335 and supervision. Therapists should use standardized assessments to measure clinical outcomes
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10 336 and provide feedback on progress.
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16 338 *Domain IV - Cognitive remediation*

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19 339 The experts in behavioral science and cognitive rehabilitation agreed on prescribing tasks that
20
21 340 are focused on functional recovery, planning the exercise centered on individual goals, and
22
23 341 understanding the patient's motivation before the treatment session. Motivational interviewing
24
25 342 or Motivation Enhancement Therapy could be used to understand their baseline motivational
26
27 343 level and establish intrinsic motivation for behavior change. Providing positive feedback and
28
29 344 reinforcement for small improvements engenders confidence in patients. Additionally, having
30
31 345 a contingency plan for days when exercises could not be performed would prevent abrupt
32
33 346 cessation of the exercise routine. Using behavioral activation (a treatment technique used in
34
35 347 clinical psychology for managing depression) so that patients perform one enjoyable activity
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37 348 each day would keep them motivated to stick to their exercise schedule.
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46 350 *Domain V - Involvement of the family members*

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49 351 Experts suggested that the family should be involved; however, the amount of assistance
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51 352 provided by the family needs to be balanced so as not to promote dependency. Assessing
52
53 353 knowledge and understanding of the caregivers on post-stroke exercises is crucial for them to
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55 354 reinforce patients' adherence. Family can be involved by being the patient's exercise partners,
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57 355 or by setting up exercise reminders, or by helping track the patient's progress. Demonstrating
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3 356 and practicing exercises with family can also enhance the self-efficacy and confidence of
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5 357 caregivers.

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8 358 Managing the expressed emotions of the family members is important as it may hinder
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10 359 treatment and restrict the patient's autonomy. Rotating family members in the supervision of
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12 360 the patient's activities can help in reducing burnout and maintaining novelty in routine.

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18 362 *Domain VI - Involvement of society/ community*

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21 363 Family and friends can interact with the patient on topics not concerning the illness (areas of
22
23 364 interest to the patient such as work/ politics/ current affairs/ sports.) Some strategies for
24
25 365 involving society include having weekly phone/face-to-face interactions with colleagues,
26
27 366 family, and friends, or joining/ creating support groups or associations of families with stroke.
28
29 367 Testimonials of recovered patients and their experiences with rehabilitation can be used for
30
31 368 motivating other patients. Additional ways to include community are awareness programs for
32
33 369 healthy adults, local group exercise for people with stroke, and peer support or exercise
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35 370 buddies.

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41 372 *Domain VII - Promoting self-efficacy*

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44 373 Experts suggested using evidence-based behavior change strategies (e.g., the Capacity
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46 374 Opportunity Motivation-Behavior model³⁶, or Intervention Mapping approach²⁵) and using
47
48 375 rehabilitation principles of substitution and optimization. Some suggested strategies to promote
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50 376 self-efficacy include

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 - Collaborating with patients to devise the best monitoring strategy for them such as

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59 378 exercise practice sheets, paper, electronic diary, or internet-based applications.

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3 379 • Providing continual support after the termination of the formal therapy program.
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6 380 • Providing personal graph charts of success that can be generated weekly or monthly.
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8 381 • Ensuring an adequate number of activities in which the patient can engage
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10 382 independently or with minimal supervision.
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12 383 • Identifying anchors in the day (sleep times/meals/activities - exercise, recreation,
13 384 social) and setting a general intention of sticking to their exercise program, or
14 385 developing contingency "if/then" plans.
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16 386 • Discuss and explore potential barriers that would impede or hinder exercise sessions
17 387 with patients.
18
19 388 • Overcome barriers using pie-charts, pros versus cons analysis/ identification of
20 389 cognitive distortions/ downward arrow techniques/ developing a life brochure/
21 390 movement, or art-based therapeutic activities.
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23 391 • Motivation interviewing to help to elicit patients' intention to adhere to exercises and
24 392 understand their motivation level.
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394 *Domain VIII - Motivational strategies*

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

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

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3 403 • Using productivity monitoring tools to keep them motivated.
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6 404 • Maintaining a daily log for positive feelings or gratitude journal, and telephone follow-
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8 405 up where the medical team provides words of encouragement can promote adherence.
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10 406 • Having video feedback at regular intervals, setting progressive but attainable targets,
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12 407 and involving patients in goal setting may motivate patients to continue exercising.
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14
15 408 • Devising wrist bands of different colors (coded for level of recovery and mastery of
16
17 409 tasks).
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20 410 • Giving t-shirts or wrist bands of that color and upgrading as they progress to encourage
21
22 411 regular exercising.
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24 412 • Competitions during group sessions among people with similar impairments and
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26 413 provide tokens or badges for improvement that can be exchanged for tangible rewards
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28 414 to make exercising fun and interesting.
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31 415 • Having an interactive internet-based community where people can add friends to
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33 416 motivate each other to exercise can also be a solution in times of social distancing.
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40 418 *Domain IX - Reminder strategies*

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43 419 Experts agreed on reminder strategies including:

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46 420 • Calling patients regularly and visiting them weekly or fortnightly.
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48 421 • Using sticky notes in the patients' homes, tally sheets, pamphlets, or SMS/WhatsApp
49
50 422 reminders.
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53 423 • Therapists can show exercise videos so that patients can accurately remember each
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55 424 exercise step and use the same video for home practice.
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3 425 • Use of technology such as sending small feedback surveys, disease information,
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5 426 scientific literature, and progress cards to keep the patients engaged and motivated to
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7 427 continue exercises.
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10 428 • Using daily logs (electronic or paper-pencil) and weekly reviewing of the exercise log
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12 to help stick to a schedule.
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431 **DISCUSSION**

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

437 The 10-item open-ended survey, used in the first round, was based on our qualitative
438 study¹⁵ that explored factors influencing adherence among stroke survivors using the
439 Intervention Mapping approach,³⁸ which is underpinned by the Socio-Ecological Model.³⁹ Our
440 framework is constructed on the Socio-Ecological Model of behavior change. Since there is
441 limited access to healthcare facilities, higher cost of clinic-based rehabilitation, and lack of
442 transport to hospital setup in low resource settings, home-based exercise adherence becomes
443 crucial for recovery. The developed adherence strategies could be influential for the success of
444 home-based rehabilitation in the long term.

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

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3 448 theory,⁴¹ activity-monitoring, feedback system, goal-setting,⁴² self-regulated exercises,⁴³ for
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5 449 improving adherence. However, none of the studies had used Delphi approaches and provided
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7 450 broad concepts for enhancing exercise adherence without providing specific context, culture,
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10 451 or techniques for delivering the interventions.
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13 452 Adherence is affected by multiple factors such as age, self-efficacy, caregiver support,
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15 453 previous exercise behavior, the severity of stroke, and stages of stroke recovery.^{18,19,20,44,45}
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17 454 Therefore, the framework of strategies provides the opportunity to individualize the strategies
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19 455 based on each person's impairments, recovery, the severity of stroke, and available support
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21 456 system. The exercises can be tailored depending on the abilities and context of each person.
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25 457 Adherence to post-stroke rehabilitation is a dynamic process and changes with each
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27 458 stage of recovery, characterized by a higher adherence rate during the initial period of recovery
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29 459 followed by a slow decrease in adherence rate and a stable phase where adherence does not
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31 460 change much.⁴⁶ Some strategies such as enhancing self-efficacy, activity scheduling, regular
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33 461 feedback, and monitoring can be initiated during the early phase while strategies such as
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35 462 interim progress tracking, personal graphs, involvement of peer group, gamification of
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37 463 exercises, providing rewards, and reminders can be started gradually to break the monotony of
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39 464 ongoing exercise programs and encourage adherence. Therefore, implementing these
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41 465 adherence strategies early in rehabilitation can be beneficial for maintaining adherent behavior
42
43 466 in the long term. The results from a meta-analysis of mixed disease populations demonstrated
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45 467 that adherence is low when perceived disease severity is high among patients with serious
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47 468 illnesses.⁴⁷ However, future studies are needed to establish the effects of stroke severity on
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49 469 exercise adherence.
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56 470 The different sets of strategies within the framework can be deployed to improve
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58 471 exercise adherence after stroke. The framework is useful for stroke survivors, caregivers, and
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3 472 healthcare providers as it offers adherence techniques at a personal, interpersonal, and
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5 473 organizational level. It gives clear recommendations on each strategy's content, different ways
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7 474 of delivering it, healthcare professionals who should design it, and one who might benefit from
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9 475 those strategies.
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13 476 The strategies that were agreed upon by more than 60% of experts were included while
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15 477 the remaining uncertain strategies were excluded. The excluded strategies were participating
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17 478 in social events, regular checks by neighbors, or games/competition with family/caregivers.
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19 479 Such strategies may improve the social interaction but may not be feasible due to the caregiver's
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21 480 burden after stroke,⁴⁸ and family members may not find adequate time for such activities. Other
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23 481 uncertain strategies such as virtual reality, circuit training, or award function were excluded
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25 482 due to the cost, training, and equipment required.¹⁵ Strategies such as educating patients on the
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27 483 location and types of stroke and educational movies were considered redundant for improving
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29 484 exercise adherence.⁴⁹ Although social media such as Whatsapp was agreed upon by the experts
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31 485 as a mode of reminder, Whatsapp groups were not preferred as a strategy due to fear of
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33 486 dissemination of inaccurate information among the participants and compromising the privacy
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35 487 of health information.
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41 488 The key strength of this study lies in the multidisciplinary nature of the expert panel
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43 489 that was recruited, which included specialists in exercise prescription, experts in behavior, and
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45 490 community experts having diverse experiences that contributed to developing a multi-faceted
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47 491 framework of strategies. Due to the pandemic that has compromised clinic-based rehabilitation
48
49 492 worldwide, these strategies can be delivered in any healthcare setting, are easy to implement,
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51 493 affordable, and offer a comprehensive set of strategies to facilitate exercise adherence. We have
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53 494 tested the framework of strategies in a recent randomized controlled trial and found it to be
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55 495 effective in improving adherence levels among people with stroke.²⁶ Choosing the strategies
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57 496 from the framework can help in the pragmatic implementation in clinical practice or research
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3 497 trials. The framework is a useful guide for both clinicians and researchers to select appropriate
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5 498 strategies for enhancing exercise adherence.
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9 499 We did not include stroke survivors and caregivers in the Delphi panel which we
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11 500 consider a limitation of this study. However, the perceptions of stroke survivors were explored
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13 501 to develop the questionnaire for the first round.¹⁵ The representation of experts from each
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15 502 specialty was unequal which could have influenced the decision-making process that
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17 503 differentiated certain versus uncertain strategies. Hence, some of the strategies deemed
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19 504 uncertain may have clinical relevance for supporting adherence. Moreover, as the open-ended
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21 505 questionnaire was developed from the literature review and opinions of stroke survivors in the
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23 506 previous study, the experts did not get a chance to develop the initial themes.
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34 509 **CONCLUSION**

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37 510 A set of strategies and a framework for enhancing adherence to home-based exercises
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39 511 after stroke has been developed and classified under nine domains: patient education on
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41 512 stroke and recovery, exercise prescription, feedback, and supervision, cognitive remediation,
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43 513 the involvement of family members, the involvement of society, promoting self-efficacy,
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45 514 motivational strategies, and reminder strategies. In countries where home-based exercises are
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47 515 the mainstay of rehabilitation, these strategies could reinforce self-management and facilitate
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49 516 adherence in the long term. Future studies should explore the experiences of stakeholders in
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51 517 implementing these strategies using qualitative methods. The set of strategies could be
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53 518 incorporated in a telerehabilitation model and cost-analysis could be performed in the future.
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3 520 **Ethics statement**
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6 521 Institutional Ethics Committee, Kasturba Hospital, Manipal, India approved this study

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8 522 (IEC:355/2017)
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15 524 **Contributorship statement**
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18 525 The study was conceptualized by JMS and MN. AM, JMS, and MN developed the protocol

19 526 and designed the methodology. AM contacted the experts and prepared the 10-item

20 527 questionnaire. AD, DLM, GV, SP, STS, ArD, SDK, GN, HS, SKV, SK, BU and CE formed

21 528 the expert panel and contributed in the development of the framework. AM analysed the data

22 529 and prepared the first draft with supervision from JMS and MN. All authors have contributed

23 530 in drafting and revising the manuscript.
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36 532 **Competing Interest**
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39 533 None declared
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49

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51 537 or not-for-profit sectors
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59 539 **Data sharing**
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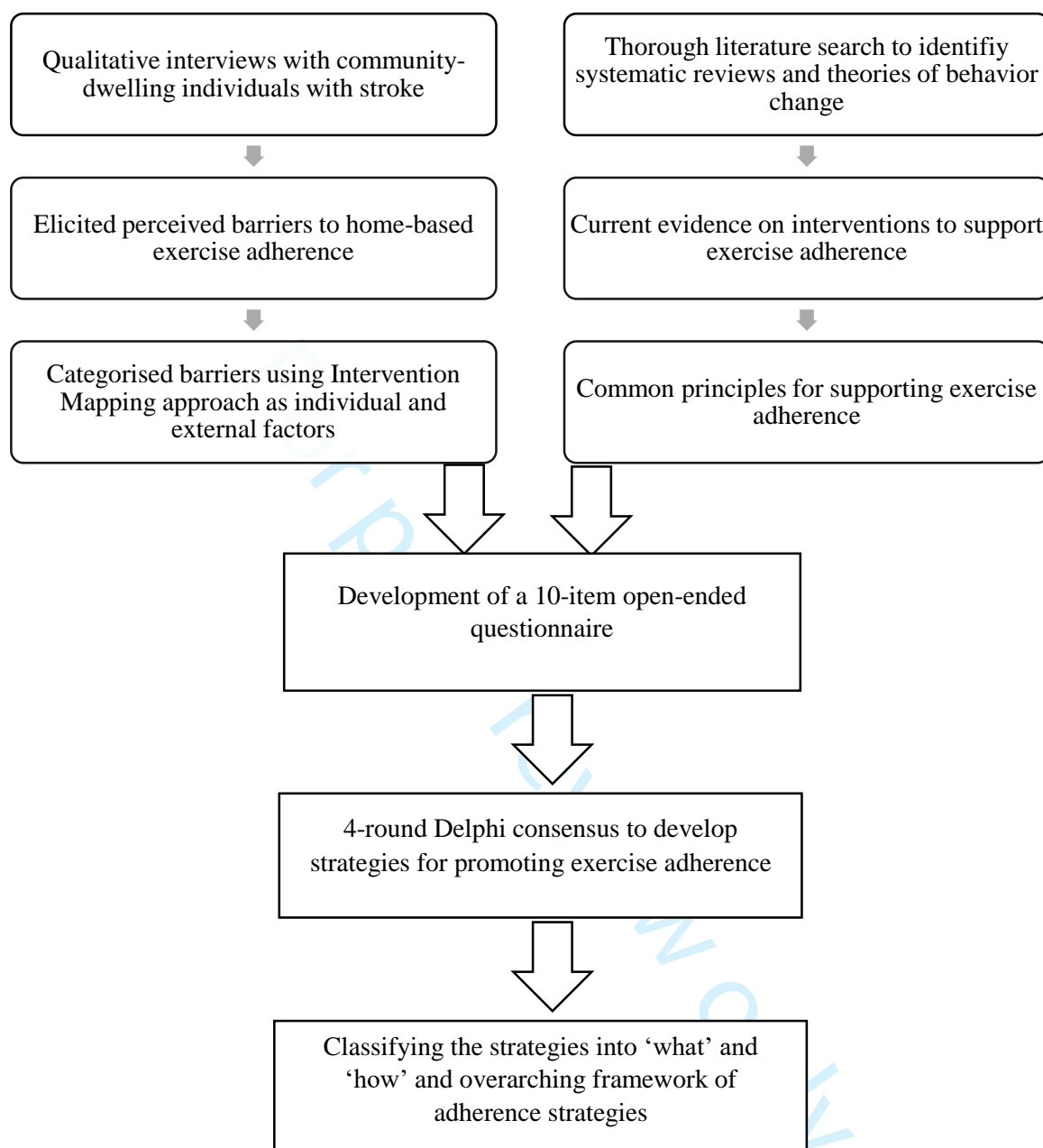
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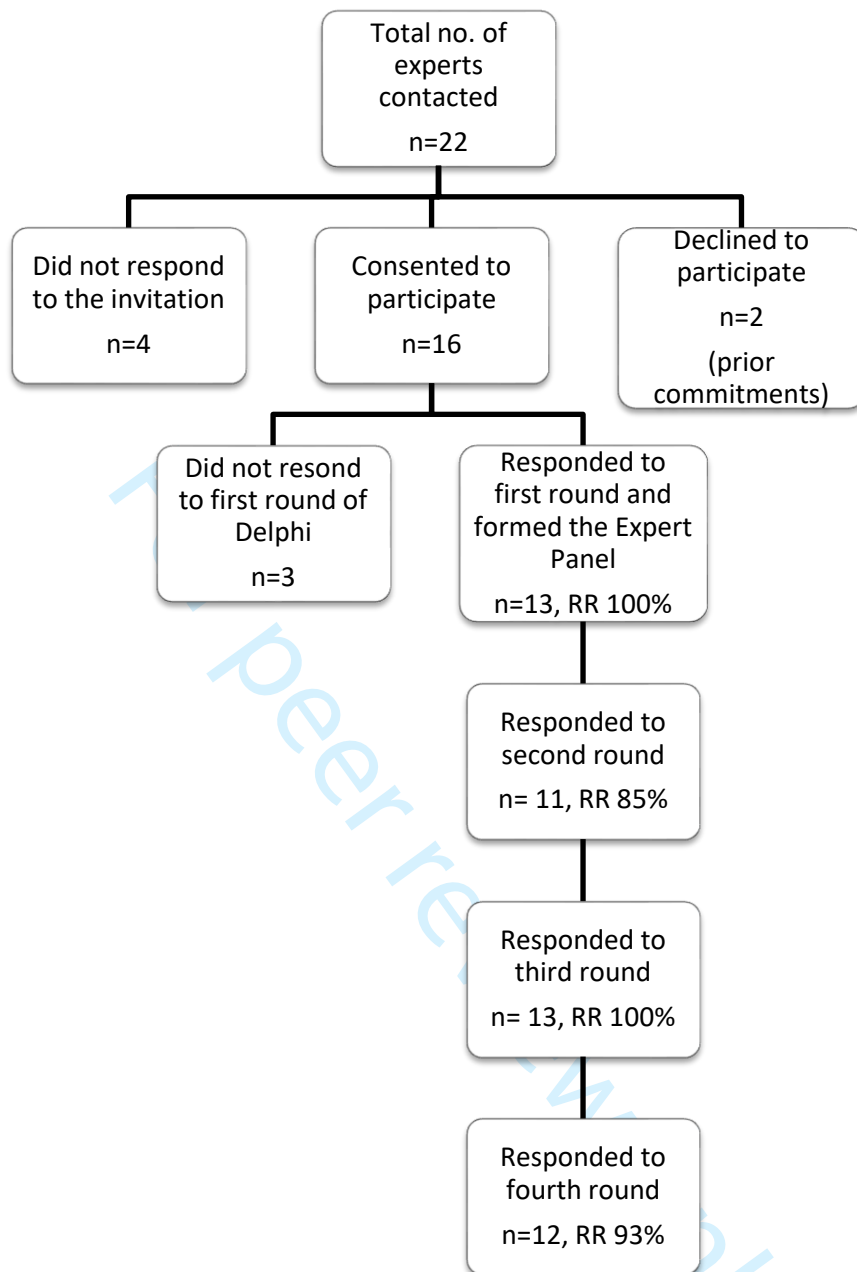
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Figure Legend

- 690
- 691 Figure 1: Process of development of adherence framework
- 692 Figure 2: Flow of participants and response rate in each round
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***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?

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

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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	<ul style="list-style-type: none"> • 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 <p>Education can be delivered via written information, group sessions, individual discussions, testimonials from recovered patients and caregivers, phone calls</p>	Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient, Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder

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2	Exercise prescription	<ul style="list-style-type: none"> • 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 	<p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	Domain	Strategies	Healthcare provider	Stakeholder

3	Feedback and supervision	<ul style="list-style-type: none"> • 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 	<p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	Domain	Strategies	Healthcare provider	Stakeholder
4	Cognitive remediation	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p>	Patient, caregiver

	Domain	Strategies	Healthcare provider	Stakeholder
5	Involvement of the family members	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p>	Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder
6	Involvement of society	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke</p>	Community

		<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient

	Domain	Strategies	Healthcare provider	Stakeholder
8	Motivational strategies	<ul style="list-style-type: none"> 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. 	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient

		<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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, Psychiatrist, 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

<p>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</p>	1/1-2
<p>Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions</p>	1/ 4-22

Introduction

<p>Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement</p>	3-4/48-76
<p>Purpose or research question - Purpose of the study and specific objectives or questions</p>	4/79-81

Methods

<p>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**</p>	5/101-103
<p>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</p>	5/107-109
<p>Context - Setting/site and salient contextual factors; rationale**</p>	NA
<p>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**</p>	5/93-99
<p>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</p>	4/85-86
<p>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**</p>	5/100-107

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3	Data collection instruments and technologies - Description of instruments (e.g.,	
4	interview guides, questionnaires) and devices (e.g., audio recorders) used for data	
5	collection; if/how the instrument(s) changed over the course of the study	6/125-129
6		
7	Units of study - Number and relevant characteristics of participants, documents,	
8	or events included in the study; level of participation (could be reported in results)	8/168-169
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10	Data processing - Methods for processing data prior to and during analysis,	
11	including transcription, data entry, data management and security, verification of	
12	data integrity, data coding, and anonymization/de-identification of excerpts	6/128-129
13		
14	Data analysis - Process by which inferences, themes, etc., were identified and	
15	developed, including the researchers involved in data analysis; usually references a	
16	specific paradigm or approach; rationale**	6/129-132
17		
18	Techniques to enhance trustworthiness - Techniques to enhance trustworthiness	
19	and credibility of data analysis (e.g., member checking, audit trail, triangulation);	
20	rationale**	7/149-151

Results/findings

23	Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and	
24	themes); might include development of a theory or model, or integration with	
25	prior research or theory	10-21/179-342
26		
27	Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts,	
28	photographs) to substantiate analytic findings	Supplementary
29		file 1

Discussion

32	Integration with prior work, implications, transferability, and contribution(s) to	
33	the field - Short summary of main findings; explanation of how findings and	
34	conclusions connect to, support, elaborate on, or challenge conclusions of earlier	
35	scholarship; discussion of scope of application/generalizability; identification of	
36	unique contribution(s) to scholarship in a discipline or field	21-23/350-408
37		
38	Limitations - Trustworthiness and limitations of findings	23-24/409-416
39		

Other

42	Conflicts of interest - Potential sources of influence or perceived influence on	
43	study conduct and conclusions; how these were managed	None
44		
45	Funding - Sources of funding and other support; role of funders in data collection,	
46	interpretation, and reporting	None
47		

*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.

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**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

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