THESIS

FLOWING FORWARD: YOGA AND SELF-MANAGEMENT FOR LONG COVID RECOVERY

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ABSTRACT

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Long COVID is a complex, multisystem condition that affects physical, psychological, and social well-being, yet treatment options remain limited. Yoga and self-management have each demonstrated benefits in chronic disease populations, but their combined use for individuals with long COVID (PwLC) has not been investigated. This single-arm pilot study evaluated the feasibility, acceptability, and preliminary outcomes of an eight-week remotely delivered intervention integrating yoga and self-management education (MY-Skills Mobile). Sixteen participants enrolled and fifteen completed the program. Feasibility was supported by high eligibility (100%), consent (70%), yoga attendance (86.7%), and self-management module completion (65%). Attrition was minimal (6.25%) and no adverse events occurred. Acceptability benchmarks were met, with participants rating the intervention highly on telehealth usability and mobile application measures, and most reporting improvements in stress, bodily comfort, and overall quality of life. Preliminary outcomes showed small positive effects in health-related quality of life (7–8% improvement, d = 0.38–0.44) and long COVID symptom burden (7.1% reduction, d = 0.25). Fatigue and pain outcomes showed mixed trends, with changes not reaching clinically significant thresholds. Findings suggest that MY-Skills Mobile is feasible, acceptable, and safe for PwLC, with promising though modest effects on quality of life and symptom

burden. Future randomized controlled trials are warranted to determine efficacy and explore scalability of this integrative approach.

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Introduction

COVID-19, a respiratory illness caused by the novel coronavirus SARS-CoV-2, emerged in late 2019 and quickly spread worldwide, leading to a global pandemic. Post-COVID syndrome, also known as long COVID, is a multisystem condition that encompasses various physical and neuropsychiatric symptoms that persist for more than 12 weeks post COVID-19 diagnosis without alternate explanation [1]. The most common symptoms include fatigue, persistent cough, shortness of breath, muscle pain, headaches, and loss of or changes to smell and taste, among others [2]. Symptoms are often not linear and vary in severity [3]. Patients with long COVID (PwLC) may endure this significant symptom load for several months following initial COVID-19 infection symptoms. Although originally considered primarily a pulmonary disease, long COVID is now known to present implications among other domains of health and/or wellness in addition to physical, including symptoms of anxiety, depression, and post-traumatic stress disorder, in which PwLC are up to two times as likely to develop [4]. Additionally, there are effects of long COVID on social well-being, comprised of self-imposed isolation and reported poor social networks among those diagnosed [5].

Despite the development of vaccines, long COVID remains a pertinent and understudied condition. Some guidelines for long COVID symptom management have been developed. In 2021, a panel of general practitioners concluded that effective long COVID management requires a comprehensive approach, incorporating targeted complication assessments, symptom cluster strategies, and individualized rehabilitation plans [6]. Potential treatment options that have been explored for PwLC include pharmacological, rehabilitative, and various integrative and complementary therapies [7]. Antidepressants are commonly prescribed for long COVID-related

psychological symptoms, but their delayed onset and potential side effects, such as headaches, insomnia, and mood changes, can prolong patient discomfort during adjustment [8]. Additionally, these medications are not likely to improve the physical symptoms of long COVID [9], [10].

Thus, there is a need for innovative treatments that can help manage both the physical and mental health symptoms of long COVID. One promising strategy is the use of "self-management", which is used to provide individuals with tools, knowledge and skills for managing a chronic condition and to achieve optimal functioning [11]. Self-management includes medication management, problem-solving and decision-making, skill enhancement, and independent symptom monitoring [11]. Self-management interventions have demonstrated improvements in health outcomes across various chronic disease populations, such as enhanced symptom control in heart failure [12] and improved disease management in type 2 diabetes [13]. These approaches have been shown to foster long-term health behavior changes and contribute to sustained improvements in well-being. Despite this evidence, self-management techniques have not yet been examined for PwLC. Given that many PwLC may be navigating chronic symptoms or disability for the first time, investigating self-management as a tool for symptom management and health maintenance is crucial.

A potential strategy to help manage the symptoms of Long COVID includes therapies such as yoga. Yoga is a centuries-old mind-body practice and has been applied as a therapeutic intervention for various chronic conditions such as asthma, type 2 diabetes, and various cancer types [14], [15]. Yoga encompasses physical postures (asanas), along with breathing techniques (pranayama) and meditation to promote overall health and well-being [16]. In recent years, yoga has become more common in Western medicinal practices, honing in on its various aspects

which can promote self-reflection, feelings of ease, and physical health benefits [17]. Yoga has been utilized as a therapeutic intervention for several chronic diseases, demonstrating improvements in many symptoms relevant to PwLC. Systematic reviews and meta-analyses have shown that yoga can reduce anxiety symptoms, improve respiratory function and decrease dyspnea in patients with chronic obstructive pulmonary disease, and alleviate fatigue and enhance quality of life in cancer patients [18], [19], [20]. Yoga has also been studied as a tool for managing symptom burden among various clinical populations, including those with hematologic diseases, cancers, and mental disorders [21] [22]. Only one intervention has examined the effects of virtual yoga in PwLC, focusing on psychological stress as an outcome. This program was found to be feasible [23]. Additionally, yoga has shown promising benefits for conditions with symptom profiles like Long COVID (e.g., dyspnea, shortness of breath, and psychological distress) [24] [25].

In summary, to our knowledge there have been no comprehensive interventions to address both the physical and psychological symptoms that affect PwLC. Combining self-management and yoga, both proven to improve physical and psychological outcomes in chronic disease, offers a novel, promising approach to alleviate symptoms in PwLC [24]. Previous studies that have combined yoga and self-management have found that such interventions are feasible and acceptable among individuals post-stroke and living with chronic pain [22] [26].

A combined self-management and yoga intervention may equip PwLC with skills to manage symptoms, while yoga can aid rehabilitation, reduce stress, improve breathing, and enhance overall well-being. However, a combined self-management and yoga intervention has never been tested among PwLC. Therefore, the purpose of this study was to (1) assess the feasibility and acceptability of a combined self-management and yoga intervention among

PwLC, and (2) explore the preliminary outcomes of the intervention on pain, fatigue, health-related quality of life, mental health, and long COVID symptoms.

Methods

Single-arm pilot study, consisting of 8 weeks of self-management and yoga, delivered remotely.

Participants

To be included in the study, participants were community-dwelling, (2) participants must be able to stand without an assistive device, and (3) participants must have an official Long COVID diagnosis. Exclusion criteria were (1) already doing ≥120 minutes of yoga a week, (2) completed self-management education in the last year, and (3) cognitive impairment limiting decision making. Participants were not excluded due to limited technology access, as loans and internet hotspots were available to participants if needed. Participants were recruited using a convenience sampling method through UC Health Integrated Medicine. Upon receiving a diagnosis for Long COVID, attending healthcare providers referred patients to the study coordinators for enrollment, where study staff screened patients for eligibility and answered any questions related to study procedures or participation. Participants were recruited from 03/2023 - 08/2023 and provided written informed consent to participate in the study. All study procedures were approved by the Colorado Multiple Institutional Review Board (COMIRB) for the protection of human subjects (22-2215).

Procedures

Sixteen participants were enrolled in two waves of trials. Upon enrollment in the study, a study staff member met with participants via Zoom to assist with logging into Canvas and described how technical support would be provided during the study. Participants were then scheduled for the baseline study visit with research staff via Zoom, where they completed baseline study assessments and medical history questionnaires, and if needed loaner equipment was provided (e.g., iPads, monitors, headphones, and speakers). After the conclusion of the intervention, participants completed post-intervention assessments. Assessments were distributed via Qualtrics, a secure remote tool, and participants were deidentified.

Intervention

The MY-Skills intervention was originally developed using a qualitative, multi-phase approach involving caregiving dyads experiencing persistent pain working with interdisciplinary clinical experts [27]. Utilizing a collective case study design, two rounds of focus groups were conducted: the first with 16 caregiving dyads, and the second with eight pain management professionals. Focus group data were analyzed using constant comparison methods to identify key themes related to pain self-management, emotional well-being, dyadic communication, and intervention logistics. These insights, combined with evidence-based frameworks such as the Stanford Model and NIH best practices, informed the development of a structured 16-session manualized intervention. The resulting program integrated self-management education with adaptive yoga, tailored to the unique needs and dynamics of dyads living with persistent pain.

This intervention, which served as the foundation for the MY-Skills Mobile intervention for PwLC, was modified to address the specific needs of this population, including pervasive fatigue, cognitive dysfunction, and the uncertain nature of the condition's trajectory. While the

intervention dose remained the same, yoga postures were altered to account for widespread symptoms such as dizziness, and the self-management component was tailored to be more specific to the population's unique experiences with the condition.

Yoga

The MY-Skills Mobile yoga intervention consisted of supervised, virtual, group-based sessions twice per week for 8 weeks via Zoom. Before the first yoga session, the lead instructor, a registered nurse and certified yoga therapist, met with each participant individually via Zoom to better understand each participant's needs, and adapt yoga postures as needed. Participants were also given a mat at this time. Yoga sessions were 60-minute-long standardized and progressive classes, and included seated, supine, and standing postures (see Table 1). Participants also had access to supplemental pre-recorded meditations, breathwork, and seated practices. Postures were modified for different ability levels, and each yoga session worked towards a "peak posture", which is the most challenging or complex posture in the sequence. The instructor would demonstrate each posture in real-time via Zoom. These sessions were paired with a "mudra", a hand gesture accompanying a meditation to promote relaxation and mindfulness, and a "mantra", a repeated word or phrase used as a guiding principle [28].

Self-Management

The self-management intervention was delivered asynchronously through Canvas, a web-based platform used to facilitate learning. It included discussion boards and educational videos about goal setting, monitoring goals, and problem-solving practice. New modules were released

weekly and were available with unrestricted access once opened. Self-management topics are listed in Table 1. The instructor reinforced the self-management module topics during the biweekly yoga sessions, with mantras integrated across both components of the intervention.

Table 1. *Yoga and Self-Management Sessions*

Session	1. Yoga Session	2. Self-Management Topic
1	Seated: Breathwork, prayer hands, intention setting	Introduction to self-management
2	Seated: Breathwork, prayer hands, intention setting	Goal Setting and Action Plans
3	Seated: Six Movements of the Spine (forwards/backward flexion/extension, lateral, bilateral twist)	Long COVID and Resource Utilization
4	Seated: Six Movements of the Spine (forwards/backward flexion/extension, lateral, bilateral twist)	Experiencing Multiple Symptoms
5	Seated: Upper Extremity Joint Freeing Series Supine: Lower Extremity Joint Freeing Series Standing: Mountain pose; Warrior	Motivation and Problem Solving
6	Seated: Upper Extremity Joint Freeing Series Supine: Lower Extremity Joint Freeing Series Standing: Mountain pose; Warrior	Body Mechanics and Yoga Modification
7	Low Cobra Standing Forward Fold Warrior II Pose Tree Pose	Stress Management
8	Low Cobra Standing Forward Fold Warrior II Pose Tree Pose	Dealing with Difficult Emotions
9	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Communication Skills: Interpersonal

10	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Communication Skills: Health Care
11	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Coping Skills and Fatigue
12	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Importance of Activity
13	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Health Eating and Decision Making
14	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Yoga as Physical Activity
15	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Applying Skills and Forming Habits
16	Knee to Chest Pose Supine Pigeon Pose Bridge Pose with Spinal Roll Down	Summary and Long-term Planning

Measures

To assess feasibility, metrics for recruitment, adherence, attrition, safety, and data collection were assessed. Acceptability was measured using the Telehealth Usability Questionnaire (TUQ) and the User Version of the Mobile Application Rating Scale (uMARS). A summary of feasibility and acceptability measures and benchmarks (e.g., goals) is provided in Table 2. Preliminary impacts of the intervention were measured using the Brief Pain Index (BPI), FACIT Fatigue Scale, Short Form Health Survey (SF-36), Long COVID Symptom Burden Questionnaire (SBQ), and Satisfaction with Yoga Questionnaire.

Table 2. *Feasibility benchmarks and measures*

Construct	Measure	Benchmark
Recruitment	Enrollment, reasons for enrollment	90% of screened patients will be eligible; 50% of eligible patients will consent to enroll
MY-Skills Mobile Use	Number of yoga sessions and self-management modules completed	>50% yoga session attendance and modules will be completed
Attrition	Disenrollment, reasons for disenrollment	<20% attrition
Safety	Tracked through adverse events occurring during synchronous yoga sessions	<10% to sustain an adverse event
Data Collection	Missing data on self-report measures	<10% missing data points
Acceptability	Telehealth Usability Questionnaire	>90% of participants to rate intervention between 5-7 (7-point scale)
Usability	User Mobile Application Rating Scale	>90% of participants to rate intervention between 3-5 (5-point scale)
Satisfaction with Yoga	Investigator-made assessment of participant's contentment with yoga sessions	n/a

Feasibility

Recruitment

Recruitment feasibility was calculated using a) the proportion of those screened who were eligible for the program and b) of those eligible, the proportion of those who consented to

enroll. The feasibility benchmarks set were 90% of screened participants would be eligible, and 50% of eligible participants would consent to enroll. To calculate eligibility, the number of eligible participants was divided by the total number of screened individuals and multiplied by 100 to obtain a percentage, presented as an average adherence rate. The consent was determined by dividing the number of participants who provided informed consent by the total number of eligible individuals and multiplying by 100. To calculate mean, median, and standard deviations, responses (eligible/not eligible, and consent/not consent) were coded as binary events.

Adherence

Adherence feasibility was divided into two measures: yoga session attendance and module completion rate. The feasibility benchmark set was >50% of yoga sessions and modules would be completed. Yoga session adherence was calculated by dividing total number of sessions attended by all participants by total number of sessions available. Adherence to the self-management modules was based on the total number of completed modules divided by the total number of available modules. Completion was captured using a Canvas "view" indicating completion.

Attrition

Attrition feasibility was assessed based on the number of participants who completed the intervention divided by the number of those enrolled and multiplied by 100 to obtain a

percentage. The feasibility benchmark set was that attrition would remain below 20%. Completed intervention was defined as having fulfilled all post-intervention assessments.

Safety

Safety feasibility was determined by reporting adverse events (AEs). The feasibility benchmark set was that less than 10% of participants would report an AE. The AE rate was calculated by dividing the number of participants who experienced an AE by the total number of participants and multiplying by 100 to obtain a percentage. An adverse event was described as one requiring medical attention and occurring during a yoga session.

Data Collection

Feasibility of data collection was calculated by dividing the number of missing data points by the total number of available data points across all assessments. The feasibility benchmark was that less than 10% of data points would be missing.

Acceptability

Acceptability was assessed using two self-report questionnaires completed by participants at the end of the intervention. The Telehealth Usability Questionnaire (TUQ) evaluates usefulness, ease of use, interface quality, interaction quality, reliability, and overall satisfaction on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) [22], [29]. Scores were analyzed for medians and included ranges. Higher scores are associated

with higher usability ratings. The TUQ was used because it includes telehealth-specific questions, making it appropriate for evaluating this Zoom-based intervention.

The User Version of the Mobile Application Rating Scale (uMARS) assesses engagement, functionality, aesthetics, and information using a combination of Likert-style ratings and descriptive response options [30]. Scores were analyzed for medians and included ranges. The responses are Likert scaled, ranging from 1 ('definitely no', or 'not at all') to 5 ('definitely yes', or 'very much'), therefore, higher scores represented higher accessibility ratings. The uMARS was used to evaluate the asynchronous portion of the intervention.

For both measures, participant-level means were first calculated by averaging responses across all items within each scale. The median of these individual means was then used to summarize group-level acceptability. The benchmark for acceptability was defined as a median, with 90% of participant scores between 5–7 on the TUQ and between 3–5 on the uMARS. Utilizing medians provides a measure of central tendency that's robust to outliers, ideal for small samples [31].

Satisfaction with Yoga

An 11-item investigator-generated satisfaction survey was distributed post-intervention. This questionnaire investigated specific domains of the yoga portion of the intervention, including assistance in symptom recovery, the most helpful aspects of the intervention, and opinions on the intervention's length, accessibility, and duration. Response options included scales describing symptoms ranging from 0-3, with 0 representing an absence of a symptom and 3 indicating a severe occurrence of a symptom. Participants were encouraged to provide

feedback related to many aspects of the intervention. Responses to each question were evaluated individually.

Outcome Measures

Fatigue

Fatigue was measured at baseline and post-intervention using the Functional Assessment of Chronic Illness-Fatigue (FACIT) Fatigue form. The FACIT Fatigue is a 13-item form asking users to rank their levels of fatigue in various aspects of daily living using a 5-point Likert scale. Response options range from mild, subjective tiredness to debilitating, overwhelming fatigue [20]. Fatigue is divided into frequency, intensity, duration, and the impact of experience on social, mental, and physical activities. Scores range from 0-52, with a higher score resulting in lower reported fatigue levels. Questions 7 and 8, pertaining to energy levels, are reverse scored. This assessment was administered pre- and post-intervention. The FACIT Fatigue has been found to be a reliable measure across diverse chronic illness populations [32].

Pain

Pain was measured at baseline and post-intervention using the Brief Pain Inventory (BPI) Short Form. The BPI intends for users to assess their pain in the context of feeling and function [33]. Questions rate pain at its worst, least, average, and current states. Pain severity and interference is rated 0 (least) to 10 (worst) for each domain. To calculate pain intensity, this score is added, and the sum is divided by 4. For pain interference, the sum of only interference ratings is divided by 7. Higher scores indicate a greater pain intensity or interference. Pain severity

indicates the self-reported level of pain extremity, while pain interference indicates the self-reported amount of pain obtrusion in daily living.

Health-Related Quality of Life and Mental Health

Health-related quality of life (HRQOL) and mental health were assessed at baseline and post-intervention using the Short Form Health Survey (SF-36). This 36-item questionnaire has subscales that measure function, pain, mental health, emotional well-being, fatigue, and perceptions of general health [34]. The form is scored 0-100, with a higher number representing better reported health. Two final scores are presented, the physical health domain and the mental health domain. wo scores are presented, physical component summary (PCS) and mental component summary (MCS). The PCS is calculated by summing the following sub scores: physical functioning (PF), role-physical (RP), bodily pain (BP) and general health (GH). The MCS is calculated by summing vitality (VT), social functioning (SF), role-emotional (RE), and mental health (MH).

Long COVID Symptoms

Long COVID Symptoms were measured at baseline and post-intervention using the Symptom Burden Scale for Long COVID (SBQ), a 134-item Likert scaled questionnaire ranging from 0 (Never) to 3 (Always). This scale was developed specifically to assess symptoms related to a Long COVID diagnosis [35], including breathing, circulation, memory, thinking and communication, movement, sleep, ear nose and throat, stomach, and other symptoms that may impact daily life [36]. Questions covered an array of health topics, ranging from bodily pain, joints, and interference, to memory, reproductive health, and sleep. The scale is summed to produce a raw score with higher digits representing greater symptom burden, which was

compared pre-post using percent change among the means. Higher scores indicate a higher symptom burden.

Data Analyses

For the primary aim, descriptive statistics including proportions, means, and medians were used to describe feasibility and acceptability outcomes. Adverse events and missing data from pre-post were reported as percentages. To explore the preliminary impact of the intervention on pain, fatigue, HRQOL and mental health, and Long COVID symptoms, mean change, percent changes and effect sizes (Cohen's *d*) were calculated. Hypothesis testing using inferential statistics was not conducted as it is neither a primary objective within pilot feasibility studies, nor are they powered to detect statistical significance [55]. Relevant minimal clinically important differences (MCIDs) were used for comparison of fatigue and pain scores.

Results

A total of N=16 participants enrolled in the intervention, and N=15 completed the intervention. Figure 1 details participant flow through the study. The sample was predominantly White (93.3%) and female (86.7%), with all participants holding a college degree or higher. Participants ranged in age from 25 to 78 years (M = 53). Additional participant characteristics are described in Table 3.

Table 3. *Participant Characteristics*

Age	53.1 (SD 14.5; range 25-78)
Sex	
Female	13 (93.3%)
Male	2 (13.3%)
Race/Ethnicity	

White	14 (93.3%)
Two or more	1 (6.7%)
Marital Status	
Single, never married	4 (26.7%)
Married	8 (53.3%)
Widowed	1 (6.7%)
Divorced	1 (6.7%)
Separated	1 (6.7%)
Education	
High school graduate or less	0 (0%)
Some college	0 (0%)
College graduate	9 (60%)
Postgraduate degree	6 (50%)
Income	
Less than $30,000	3 (20%)
$30,000-$49,999	0 (0%)
$50,000-$74,999	3 (20%)
$75,000 or more	7 (46.7%)
Choose not to answer	2 (13.3%)

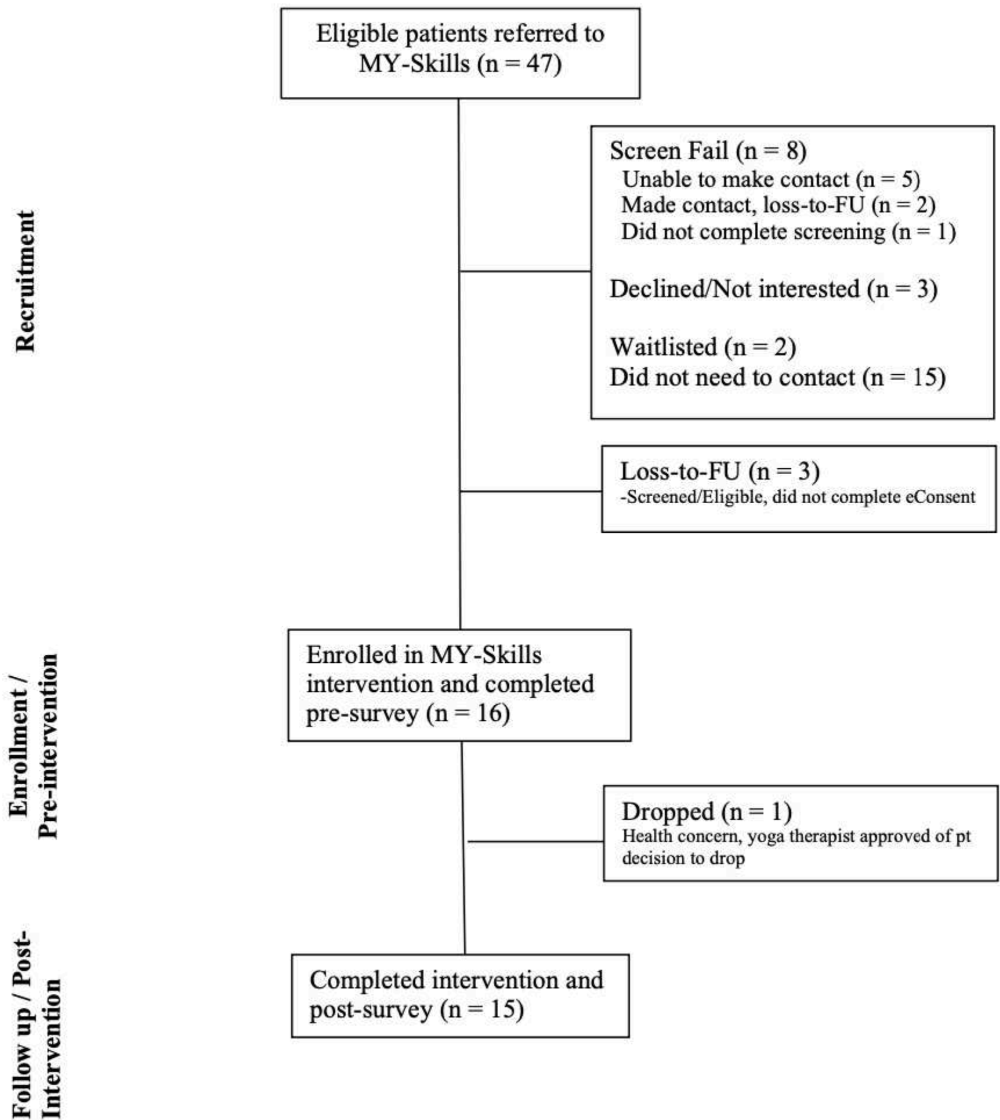

Figure 1. *CONSORT Flow Diagram*

Feasibility

Feasibility results are summarized in Table 4. The following benchmarks were met or exceeded: attendance, attrition, safety, data collection, acceptability, usability.

A total of 47 participants were screened for eligibility and 16 enrolled, which was the maximum enrollment for this program. Reasons for not enrolling can be seen in Figure 1. Of those who were referred to the program, 100% (*N*=47) were eligible, and of those eligible, 70% (*N*=33) consented to participate. These findings suggest that the eligibility and consent feasibility benchmarks were attained.

Of the 16 yoga sessions available to each of the 15 participants (240 total), there were a total of 32 absences, making the total attendance rate 86.6%. All participants (*N*=15) completed at least 50% of yoga sessions, and 93.3% (*N*=14) completed at least 75% of yoga sessions offered. The average adherence was 13.87 sessions per participant. Of the 16 modules available to each of the 15 participants (240 total), there were a total of 84 incomplete modules, making the module completion rate 65%. 73% of participants (*N*=11) completed at least half of the modules, and 53% (N=8) completed at least 75% of modules. The average adherence was 10.40 modules per participant. The attainment of the benchmark for MY-Skills Mobile use suggests that this criterion was feasible.

One participant withdrew from the study, resulting in a retention rate of 93.75%, and no adverse events were reported throughout the program. The attainment of the benchmark for attrition and safety suggests that this criterion was feasible.

Per each of the 15 respondents, there were 196 data points available in the pre-intervention section and 275 available in the post-intervention section. 60 total data points were missing from the pre-intervention section and 406 from the post-intervention section for a

combined 6.5% (*N*=466) of data points missing. Questions related to non-pertinent gendered items, optional selections, or voluntary feedback-based items were automatically subtracted from the missing data points. The attainment of the benchmark for data collection suggests that this criterion was feasible.

Table 4. *Feasibility results*

Recruitment	90% of screened patients will be eligible	100% (N=47)
	50% of eligible patients will consent.	70% (N=33)
MY-Skills Mobile Use	>50% of yoga session attendance	86.67%
	>50% of modules will be completed	65%
Attrition	<20% attrition	6.25% (N=1)
Safety	<10% of participants to report an adverse event	0% (N=0)
Data Collection	<10% missing data points	6.5%
Acceptability	>90% of participants to rate intervention between 5-7 on 7-point scale	100% (N=15)
Usability	>90% of participants to rate intervention between 3-5 (5-point scale)	100% (N=15)

Acceptability

Telehealth Usability Questionnaire (TUQ)

206 of 239 total responses captured through the TUQ rated acceptability between 5-7 on the scale, with 100% of the median responses falling between 5-7, indicating high perceived acceptability across multiple dimensions of the intervention. This high level of agreement across both individual responses and participant-level summaries suggests that participants not only found the intervention acceptable overall, but also rated it favorably across nearly all dimensions. The consistency of median scores above 5 is particularly noteworthy in a small sample, where variability is often higher. These findings surpass the predetermined benchmark for feasibility.

User Version of the Mobile Application Rating Scale (uMARS)

The uMARS assessment was scored across four subscales: engagement, functionality, aesthetics, and information. The subscale means were as follows: engagement (3.46), functionality (3.80), aesthetics (3.67), and information (4.94), resulting in a total mean score of 3.97. Scores were analyzed using medians, and ranges were also reported. Overall, 81.9% of individual item scores fell within the 3–5 range, indicating general acceptability. 100% of participant-level median scores across the uMARS subscales fell within the 3–5 range, meeting the predefined benchmark for feasibility.

Satisfaction with Yoga

Participants rated the yoga group an average of 7.78/10 in aiding recovery. Most (73.3%) reported symptom improvement, and 80.0% intended to continue yoga. Yoga Nidra, Savasana,

and Restorative yoga were rated most helpful; the “So Hum” mantra and Journaling were least helpful. The group was considered accessible (86.7%), with the session duration rated appropriate by all. Key benefits included reduced stress/anxiety, improved bodily comfort, and better quality of life. Most (73.3%) were extremely likely to recommend the program.

Table 5. *Satisfaction with Yoga Questionnaire results.*

Question	Result
1. On a scale from 1-10 how helpful was this yoga group in your recovery? (10 is most helpful)	Average: 7.78/10
2. Do you feel that yoga helped you with your symptoms of long-COVID?	Yes: 11 (73.3%) No: 3 (20.0%) No response: 1 (6.7%)
3. Of the following yoga practices (items below), what were the top three most helpful things you learned or experienced in the group? What was the least helpful?	Most helpful: Yoga Nidra/guided relaxation: 9 votes Savasana/final relaxation: 8 votes Restorative yoga: 6 votes Least helpful: "So Hum" Mantra: 10 votes Journaling: 8 votes Standing yoga postures: 6 votes
4. Do you think you will continue with yoga to help your symptoms of long-COVID? If so, why? If not, why not?	Yes: 12 responses (80.0%) For health benefits: 6 responses For social connection: 3 responses Maybe: 2 responses (13.3%) With decreased intensity: 2 responses Already practiced regularly, will continue: 1 response (6.7%)
5. Accessibility of group:	Accessible: 13 (86.7%) Too difficult: 1 (6.7%) Too easy: 1 (6.7%)
6. Time duration of group:	Not enough time: 0 (0%) About right: 15 (100%) Too much time: 0 (0%)
7. Time length of group (twice a week for eight weeks):	Not enough: 6 (40.0%) About right: 9 (60.0%) Too long: 0 (0%)
8. Which of the following, if any, did this group help support you in your long-COVID recovery? Select as many as you'd like.	Managing pain: 2 responses Improved ability to manage anxiety, stress: 9 responses Improved comfort in body: 7 responses Managing fear of the unknown parts of Long COVID: 7 responses Improved overall quality of life: 7 responses Connecting with other survivors: 2 responses

9. How likely would you recommend this yoga group to others with Long COVID?	Extremely unlikely: 2 (13.3%) Somewhat unlikely: 0 (0%) Neutral: 1 (6.7%) Somewhat likely: 0 (0%) Extremely likely: 11 (73.3%)
10. Please share any additional feedback or suggestions for improvement:	General appreciation and value of the program: 2 responses Wish for extended duration: 2 responses Wish for easier modifications: 1 response

Post-intervention survey results indicated high acceptability and perceived benefit of the yoga program among participants with Long COVID, with the majority reporting improved stress management, accessibility, helpfulness of relaxation-based practices, and a strong likelihood of continuing or recommending the program.

Preliminary Outcomes

Fatigue

Fatigue levels increased slightly over the course of the intervention, with a –2.77% change indicating a shift toward greater fatigue. The corresponding effect size was small (d = 0.15). The PROMIS-Fatigue Scale's minimal clinically important difference (MCID) is 4.7 points, based on COPD guidelines due to the lack of Long COVID-specific thresholds [37]. This threshold was not met, suggesting the change was not clinically meaningful.

Pain

The percentage change in pain interference was -4.57%, suggesting a slight decrease over the intervention period. The corresponding effect size was $d = 0.10$, which is considered a very small effect according to conventional benchmarks. The percentage change in pain severity was 2.78%, suggesting a slight increase over the intervention period. The corresponding effect size was $d = 0.06$, which is considered a very small effect according to conventional benchmarks. The BPI minimal clinically important difference (MCID) is 2 points, based on fibromyalgia MCID guidelines due to the absence of established MCIDs for Long COVID [38]. This MCID was not met, suggesting no clinical difference in fatigue levels pre-post.

Health Related Quality of Life and Mental Health (HRQoL)

Both mental and physical health domains demonstrated modest improvements from pre- to post-intervention, suggesting a positive trend toward enhanced well-being. Although no established Minimal Clinically Important Differences (MCIDs) are available to interpret the clinical significance of these changes, the observed increases - 7.64% for mental health and 8.18% for physical health - indicate a meaningful shift in participants' reported outcomes. These

gains were further supported by calculated effect sizes of 0.38 and 0.44, respectively, which fall within the small-to-moderate range and suggest that the intervention may have had a small but beneficial impact on both psychological and physiological health dimensions.

Long COVID Symptoms

Long COVID symptoms showed signs of improvement, particularly in pain severity. Specifically, there was a 7.06% reduction in reported pain levels from pre- to post-intervention, indicating a modest decrease in symptom burden over the course of the study. The associated effect size was $d = 0.25$, interpreted as a small effect. While this effect is modest, it suggests that the intervention may have contributed to alleviating pain symptoms, potentially offering a meaningful improvement for individuals managing the persistent effects of Long COVID.

Table 7. *Results table depicting preliminary effects.*

	Baseline Mean (SD)	Post-Intervention Mean (SD)	% change	Effect size (Cohen's *d*)	MCID
Fatigue	40.80 (7.06)	39.67 (8.16)	-2.77%	0.15	4.7 points
Pain Interference Pain Severity	4.59 (2.21) 4.67 (1.83)	4.38 (2.67) 4.80 (2.21)	-4.57% 2.78%	0.10 0.06	2 points
HRQoL	PCS: 38.17 MCS: 40.11	PCS: 41.08 MCS: 43.39	PCS: 7.64% MCS: 8.18%	PCS: 0.38 MCS: 0.44	No relevant MCID
Long COVID Symptoms	231.33 (36.62)	215.00 (55.18)	-7.06%	0.25	No established MCID

Percent change scores and effect sizes are reported to reflect pre- to post-intervention differences. Notable improvements were observed in both the physical and mental components of HRQoL, with increases of 7.64% and 8.18%, respectively, and small-to-moderate effect sizes (d = 0.38 and 0.44). Long COVID symptom severity decreased by 7.06%, with a small effect size (d = 0.25). Fatigue and pain scores showed minor changes, with small effect sizes ranging from 0.06 to 0.15.

Discussion

The purpose of this pilot study was to examine the feasibility, acceptability and preliminary effects of "MY-Skills Mobile", a combined yoga and self-management program for PwLC delivered remotely. Metrics for recruitment, eligibility, adherence, attrition, adverse events, acceptability, and usability met or exceeded the pre-defined benchmarks for feasibility. Preliminary effects on fatigue showed improvements among pain intensity, health related quality of life and mental health, and Long COVID symptoms. Setbacks were observed among fatigue and pain intensity.

Feasibility

Feasibility was evaluated through recruitment and consent rates, MY-Skills Mobile app usage, attrition, adverse events, and data collection completeness. All feasibility benchmarks were achieved, reflecting the intervention's practicality and potential for more rigorous trials and implementation.

Eligibility, recruitment, MYSkills Mobile use, yoga session attendance, module completion, and data collection met feasibility benchmarks. The virtual format likely supported adherence, with participants citing the convenience of remote access and the supportive group environment as facilitators. Similar studies have also reported high engagement in remotely delivered mind-body interventions, especially when sessions are adapted to meet varying physical abilities [40].

Attrition was minimal, and no adverse events were reported, suggesting the intervention was safe and acceptable. The availability of physical modifications likely contributed to participants' sustained involvement.

Acceptability

Post-program questionnaires showed high acceptability of the program, with 86.7% of participants reporting it as accessible and 73.3% finding it beneficial for their Long COVID symptoms. Telehealth usability and mobile app acceptability were rated favorably, with medians of 5-7 and 3-5 on 7-point and 5-point scales, respectively, reflecting overall positive feedback despite the small sample size. These findings are consistent with other studies on telehealth interventions for chronic conditions, where accessibility and usability ratings often correlate with higher adherence and perceived benefit [42]. These results suggest that virtual delivery formats are well-received and effective for symptom management in Long COVID, aligning with similar trials in chronic illness populations where telehealth and mobile applications have demonstrated strong user acceptability and positive impacts on patient outcomes.

Preliminary Outcomes

As a pilot feasibility study, this study was not designed or appropriately powered to detect statistically significant effects, as the primary aim was to evaluate feasibility, acceptability, and implementation procedures. However, examining initial trends among fatigue, pain severity and intensity, symptom burden, and health-related quality of life offer valuable insights for designing a larger trial [43]. Compared to other published interventions for individuals with Long COVID, the results of this study appear consistent with the current literature.

Small effect sizes (Cohen's $d \leq 0.25$) were observed across all outcome measures. Fatigue, a hallmark symptom of Long COVID, saw a slight worsening in this sample (−2.77%), which may initially seem counterintuitive. However, previous trials of exercise-based interventions have also reported transient increases in fatigue during the early stages of physical

activity programs [44]. This phenomenon is often attributed to the body's adaptation to new physical demands and may not represent long-term worsening.

While pain intensity increased slightly (+2.78%), pain severity decreased (−4.57%). These findings may reflect the effects of yoga, where DOMS (delayed onset muscle soreness) can temporarily elevate perceived pain [45], while improvements in physical function, flexibility, and proprioception from consistent practice may reduce chronic pain experiences over time. Other interventions, such as graded exercise therapy (GET), have reported similar challenges, with participants sometimes experiencing temporary pain flares before functional improvements [46].

Importantly, the intervention showed notable improvements in health-related quality of life (HRQOL), with a 7.64% increase in physical component scores (PCS) and an 8.18% increase in mental component scores (MCS). These gains are on par with, and in some cases exceed, those reported in multimodal programs that include cognitive behavioral therapy (CBT), pulmonary rehabilitation, or mindfulness-based stress reduction (MBSR) [47] [48]. The integration of yoga and self-management education likely contributed to this result: yoga may support physical recovery and emotional regulation, while self-management education equips individuals with tools for coping and regaining autonomy over health [49].

Perhaps most notably, a 7.06% decrease was observed in overall symptom burden, the largest percent change among outcomes measured. This reduction aligns with studies using mind-body interventions tailored to Long COVID populations, which emphasize individualized pacing, breathwork, and psychological support [50] [51]. Given that many Long COVID

symptoms are exacerbated by stress, the mindfulness and breath control components of yoga may serve as important therapeutic mechanisms.

Overall, while the magnitude of changes was small, the positive direction of most outcomes is promising. These trends mirror early findings from other integrative interventions and suggest that combining movement with mindfulness and education may offer a uniquely effective model for addressing the multifaceted nature of Long COVID.

Strengths and Limitations

One strength of this study is the novelty. To our knowledge, there are no other interventions combining yoga and self-management as a holistic therapy for Long COVID patients. Additionally, there are still no widely accepted treatment paths for Long COVID, as symptoms can vary between patients. Being that this intervention uses yoga and self-management, both of which can target individualized symptoms, it presents a novel approach to a disease with few treatment options. An additional strength lies in the virtual nature of this intervention. This is a strength because virtual interventions have been touted as future directions in related studies due to their accessibility and broad reach, especially important in a population experiencing what may be their first chronic illness and experiencing accessibility issues. A third strength is the use of pre-defined benchmarks and well-established validated questionnaires for several metrics. This approach enhances the credibility of the findings by ensuring that measurements are both reliable and comparable across studies. By grounding the evaluation standardized tools, the study minimizes subjective interpretation and allows for more optimal assessment of change over time. Per the National Center for Complementary and Integrative Health, when designing a pilot study, it is crucial to establish clear quantitative benchmarks for feasibility measures to evaluate the study's success or lack thereof [52].

Acknowledging limitations, the study utilized a single-arm design, in which there was no control group present. While this design is appropriate for feasibility trials, it limits the ability to attribute observed changes solely to the intervention and reduces generalizability of results derived from measures preliminary effects. A second limitation was sample homogeneity, specifically pertaining to race and sex. The sample was disproportionately white (93.3%), and female (93.3%), which limits generalizability. A third limitation of the study was the use of Canvas 'views' as a measurement tool, as opposed to a standard data entry/handling software such as REDCap. Canvas provided limited options for validating module completion, a primary feasibility outcome. The addition of a completion checkpoint such as a quiz may aid in confirming participant engagement and verifying that key content was reviewed, thereby strengthening the validity of the feasibility data.

Future Directions

This study provides important information on the feasibility, acceptability, and preliminary findings of a virtually delivered yoga and self-management intervention. Based on established models of intervention development, the logical next step after demonstrating feasibility is to conduct a pilot efficacy trial, such as a randomized controlled study. Given that this virtually delivered yoga and self-management intervention was found to be safe, feasible, and well-recieved by individuals with Long COVID, it is appropriate to advance this study into a clinical trial setting which can rigorously test whether this intervention meaningfully improves Long COVID symptoms.

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Supplementary Tables

#	**Program Satisfaction** (Likert scale response ranging from 1 Definitely no to 7 Definitely yes)	**Mean, Median (Range)**
1	Telehealth improves my access to healthcare services	6.4, 7 (4-7)
2	Telehealth saves me time traveling to a hospital or specialist clinic	6.85, 7 (6-7)
3	Telehealth provides for my healthcare needs	6.07, 6.5 (4-7)
4	It was simple to use this system	6.53, 7 (4-7)
5	It was easy to learn to use the system	6.40, 7 (4-7)
6	I believe I could become productive quickly using this system	6.43, 7 (4-7)
7	The way I interact with this system is pleasant	5.60, 6 (2-7)
8	I like using the system	5.40, 5 (1-7)
9	The system is simple and easy to understand	5.93, 5 (1-7)
10	The system is able to do everything I'd want it to be able to do	5.50, 6 (1-7)
11	I could easily talk to the clinician using the telehealth system	6.40, 7 (4-7)
12	I could hear the clinician clearly using the telehealth system	6.20, 7 (3-7)
13	I felt I was able to express myself effectively	6.36, 7 (3-7)
14	Using the telehealth system, I could see the clinician as well as if we met in person	5.60, 6 (1-7)
15	I think the visits provided over the telehealth system are the same as in-person visits	4.79, 6 (1-7)
16	Whenever I made a mistake using the system, I could recover easily and quickly	4.79, 6 (1-7)
17	The system gave me error messages that clearly told me how to fix problems	5.38, 5.5 (3-7)

Table 6. *Telehealth Usability Questionnaire results*

#	**Program Usability** (Likert scale response ranging from 1 Definitely no to 5 Definitely yes)	**Mean, Median (Range)**

1	Is the platform fun/entertaining to use? Does it have components that make it more fun than other similar applications?	3.64, 3.5 (1-5)
2	Is the platform interesting to use? Does it present its information in an interesting way compared to other similar applications?	3.86, 4 (2-5)
3	Does it allow you to customize the settings and preferences that you would like?	2.54, 3 (1-4)
4	Does it allow user input, provide feedback, contain prompts?	3.08, 3 (1-4)
5	Is the platform content appropriate for the target audience?	4.15, 4 (3-5)
6	How accurately do the features and components work?	4.15, 4 (3-7)
7	How easy is it to learn how to use the platform; how clear are the menu labels, icons, and instructions?	3.77, 4 (3-5)
8	Does moving between screens make sense?	3.46, 3 (3-4)
9	Do taps/swipes/pinches/scrolls make sense?	3.85, 4 (3-5)
10	Is the arrangement and size of buttons, icons, menus and content on the screen appropriate?	3.78, 4 (3-5)
11	How high is the quality/resolution of graphics used for buttons, icons, menus and content?	3.78, 4 (3-5)
12	How good does the platform look?	3.46, 3 (3-5)

Table 7. *User Version of the Mobile Application Rating Scale results*