Telerehabilitation Intervention Protocols for COVID-19 Patients: A Scoping Review

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ABSTRACT

Introduction: Ever since the start of the pandemic, it became clear to physical therapists through evidence that there are better outcomes in symptoms among COVID-19 patients if they undergo physical therapy; however, face-to-face rehabilitation of COVID-19 infected patients places physical therapists at risk of cross-infection. To address this issue, the use of telerehabilitation as a mode of delivery for instruction and even patient monitoring was considered. Authors also expressed their opinions on telerehabilitation. Salawu, et al. (2020) cited that at the time, there was still little to no evidence proving the effectiveness or high efficacy of telerehabilitation. Recent studies such as Turcinovic et al. (2021), Lei et al. (2021), Rodriguez-Blanco et al. (2021) and others have expressed its effectiveness; however, there are still no available standardized protocols or clinical practice guidelines for the telerehabilitation of COVID-19 patients. Thus, this study seeks to conduct a comprehensive search of the published literature regarding COVID-19 physical therapy interventions and to map out the current evidence and knowledge gaps surrounding the research methodologies and telerehabilitation treatment plans of COVID-19 patients.
Methods: The study used a Scoping Review Design in accordance with the PRISMA-ScR guidelines. In this study, 939 articles were found through searching in the following databases with specific MeSH terms: PEDRO, PubMed, BioMed Central, & Cochrane Central. These 939 articles were then screened and assessed for their eligibility - specifically, to match the inclusion criteria of the study, leaving only 9 studies to be reviewed. Specific details of each of the 9 studies were listed on a table. The details included the following: 1) Title, 2) Author & Country, 3) Digital Technology Used, 4) Research Design, 5) Methodology, 6) Interventions/Program, and 7) Key Findings/Results. Similar details between studies were tallied and compared to other existing forms of literature.
Results and Discussion: A total of 9 studies were reviewed and eventually had the details of their study listed on a table. Similar details between studies were tallied as well. The studies were conducted in Spain (3), China (2), Brazil (2), Japan (1), USA (1), and Iran (1). A majority of the studies were RCTs (4) followed by Systematic Reviews/Meta- Analyses (3). The most common interventions used in that order were Strengthening Exercises, Deep Breathing Exercises, and Aerobic Exercises. In terms of outcome measures, 6-Minute Walk Test (3) and 30-Second Sit to Stand Test (3) were the most commonly used. The most used telerehabilitation technology was any internet-connected device that has access to video conferencing (6). Four of the studies have shown better outcomes as a result of telerehabilitation.
Conclusion. This study was able to map out the available research and the surrounding protocols conducted through telerehabilitation for COVID-19 patients. The current review has shown that there are numerous studies available; however, the number that matches the inclusion criteria of the review are not abundant. The study inherently did not create any conclusions with regard to comparing among the chosen studies on what the most effective protocols are, but have only presented the current literature to future researchers who seek to systematically compare said studies which in turn would create a gold-standard for the telerehabilitation of COVID-19 patients.

Key words: Telerehabilitation, coronavirus disease - 2019 (COVID-19), scoping review

Telerehabilitation is an alternative platform that enables healthcare delivery that can cover therapeutic interventions for the management of disease and enhances patient and Physical Therapy (PT) communication during the COVID-19 pandemic.[1] The need for finding means to provide PT and rehabilitation programs for COVID- 19 patients stems from the impairments caused by the disease with some examples being: difficulties in functional independence, musculoskeletal symptoms and cardiovascular symptoms (DVTs) due to immobility, and respiratory difficulties which can be addressed through proper PT treatment plans and interventions.

The Philippines is one of the many developing countries in the world that is also facing challenges to the adoption of telerehabilitation including resistance to change, inadequate rapport, poor patient participation, a lack of training on virtual patient evaluation and management, lack of protocol expertise, or the necessity to alter protocols in order to deliver telerehabilitation services.[2] This in turn affects the insufficient data regarding different telerehabilitation interventions focusing on patients with COVID-19. In international studies regarding telerehabilitation assessment and rehabilitation for patients with COVID-19, it has been found that remote or telerehabilitation programs for COVID-19 patients are effective in improving their endurance, pulmonary function, lower limb strength, and ability to perform Activities of Daily Living. In other articles, including ones by Lei, et al. (2021)[3], and Pastora- Bernal, et al. (2021)[4], it has been estimated that there is an efficacy and benefit of pulmonary telerehabilitation among discharged patients of COVID-19 and their quality of life. On the other hand, a study by Turcinovic, et al. (2021)[5] went on with a different approach to strengthen the application of telerehabilitation in combination with direct rehabilitation programs for better results, especially for patient satisfaction.

Despite the increasing number of studies conducted discussing the telerehabilitation approach to COVID-19, based on Salawu, et al. (2020)[6], there is little or no evidence that proves its effectiveness or efficacy. Furthermore, it has also been noted that patients with severe conditions that require highly specialized input would still require a face-to-face assessment for direct intensive care. In the process of assessment, Lei, et al. (2021)[3] have stated that their study lacked the measurement of respiratory muscle strength and fatigue that could have been essential in guiding training intensities in their pulmonary telerehabilitation interventions. For the limitations of studies according to study design, the pilot randomized controlled trial by Rodriguez-Blanco, et al. (2021)[7] was limited due to its design being a pilot study; the data gathered was insufficient to detect the long- term effect of the therapeutic exercise program conducted through telerehabilitation on the physical function of patients with COVID-19. The feasibility and pilot implementation of the telehealth study by Turcinovic, et al. (2021)[5] has some limitations, such as having no contact with participants post-discharge. Therefore, in order to validate the effectiveness of telerehabilitation, a longer and more comprehensive study is needed to analyze the efficiency and cost-effectiveness of telerehabilitation for patients with COVID-19 in the long term.

This study was done to provide information and knowledge regarding the effective physical therapy intervention protocols for patients diagnosed with COVID-19 in the setting of telerehabilitation. The findings obtained through review of recent studies in relation to the topic will have expected importance to future researchers, as the different medical approaches for coronavirus have only been emphasized at the beginning of the pandemic last 2019 to 2021. There is still need for studies that can fully determine an effective and standardized online management of patients with COVID-19. This study will guide novice researchers to map out and discover credible, reliable, and valid data from the selected studies for further understanding of the topic. The findings of this study will also provide students with knowledge on the added scope of physical therapy management in relation to COVID-19. It can also help the students in formulating targeted and alternative intervention protocols for case studies, reports, and journal critiquing. In the field of physical therapy, this study will be able to assess and summarize various evidence-based practices in the management of patients with COVID- 19 that clinics may be able to adapt to further widen the scale of physical therapy services in addressing COVID-related health problems. Treatment protocols that included in this study can also aid physical therapists in selecting the appropriate intervention strategies delivered online for different individuals in need of rehabilitative care due to COVID-19. This paper will help society as well to further widen the understanding and interpretation of the topic, as the study covers rehabilitation of COVID-19 that factors in the importance of social

care. Overall, this study wants to know what treatment protocols and managements are available for physical therapists who seek to remotely treat COVID- 19 patients.

The main objective of the study was to identify the current evidences surrounding the research methodologies and telerehabilitation treatment protocols of COVID- 19 patients. Specifically, this study aims to examine the limitations and gaps of the present studies regarding the topic and to serve as a reference for future systematic research concerning rehabilitation protocols for COVID-19 and its long term effects on patients.

Ethical Consideration

This study was classified by the FEU-NRMF Institutional Ethics Review Committee (FEU-NRMF IERC 2023-0001) as Exempted from ethics review.

MATERIALS AND METHODS

This study made use of the Scoping Review Approach method for research evidence synthesis as outlined by Sucharew & Macaluso (2019)[8] to properly create a scoping review with the goal of end purpose of describing existing literature and other findings from a range of different study designs and methods.

Study Design

The authors performed a scoping review to identify the gaps in the research and identify the need for further investigation. It focuses on mapping the existing literature in terms of volume, nature, and characteristics of the primary research.[9] This would help measure the extent, range, and nature of Telerehabilitation Intervention Protocols for COVID-19 patients, find out the value and scope, summarize and distribute the relevant information, and identify the research gaps in the study.[9] In alignment with PRISMA-ScR, it will serve as updated guidance to improve conducting and reporting of the scoping review.[10] Both manual screening and the JBI Sumari Software were used to individually screen each study.

Study Selection

- Studies written in English or studies with direct English translations
- Published studies on telerehabilitation of COVID-19 patients written between 2019 and 2023
- Studies from the institution's affiliated databases such as EBSCO Host
- Randomized controlled trials, feasibility studies, systematic reviews, and scoping reviews that focused on COVID-19 rehabilitation

Scope of the Study

Inclusions	Exclusions
Published from 2019 and until present	Published before 2019
Systematic reviews	Incomplete reports or unconducted RCTs
Meta-analyses	Not within scope of Physical Therapy intervention
Randomized controlled trials	Study participants that are candidate for direct rehabilitation of COVID-19
Rational and design studies	Studies that do not specify treatment program
Feasibility studies	Studies with participants that are only asymptomatic with COVID-19
Studies regarding telerehabilitation of patients having COVID-19	Studies regarding telerehabilitation of patients who had post-COVID-19

Sampling Methodology

The authors utilized the PRISMA flow chart (Figure 1) in order to exhibit each phase of this scoping review. The team gathered various studies related to the telerehabilitation of COVID-19 patients from reliable sources such as PubMed, PEDRO, BioMed Central, & Cochrane Central. Each article was screened based on the inclusion and exclusion criteria of this study. These were among the research

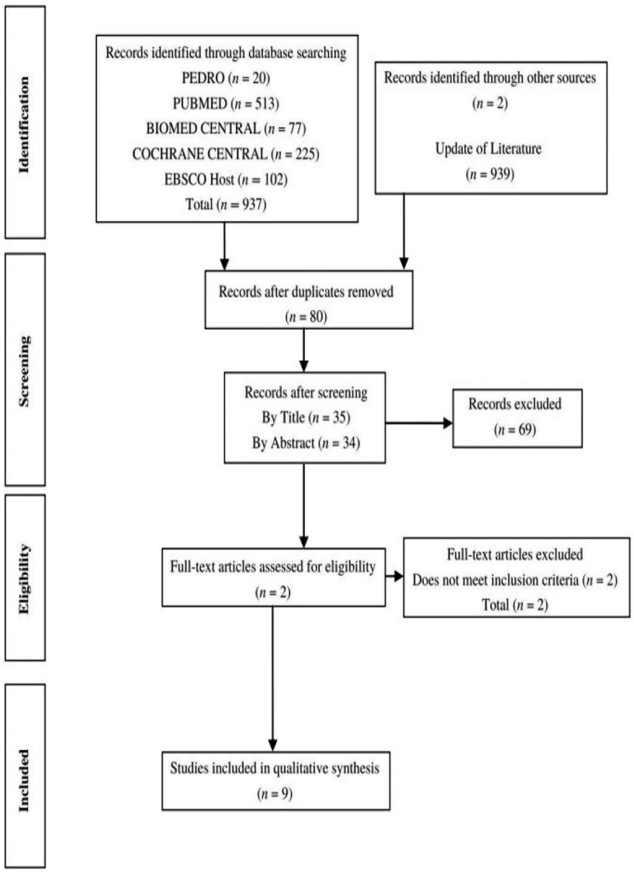

Figure 1. PRISMA flowchart.

databases used to collect relevant data for the study in order to show an analysis of how different types of telerehabilitation affect a specific sample. The constituents of the study planned to identify the advantages and disadvantages of the different types of research that were presented in this study to accomplish the goals and objectives of the research.

Search Strategy

The authors have gathered various literature published from 2019 to 2023 for the scoping review and made use of the PCC (Population, Concept, and Context) mnemonic presented in Table 1 as a guide with the target population of COVID-19 patients and Telerehabilitation. The following Medical Subject Headings or (MeSH) terms were used: "COVID 19"; "Intervention"; "COVID 19" AND "Physical Therapy"; AND "Telerehabilitation". Filters were applied to only include literature that satisfied the inclusion criteria.

The following information were gathered from the selected studies: Title & DOI, Author/Year/Country, Type of digital technology, Research design, Methodology, Interventions/program and Key findings/results.

RESULTS

Table 3 presents 9 articles/studies of varying methodologies, study designs, source country, treatment plans, and results published between 2019 and 2023. Studies were conducted in Spain (3), China (2), Brazil (2), Japan (1), Russia (1), USA (1), and Iran (1). The 9 articles/studies consist of 4 randomized controlled trials (3), systematic reviews/ meta-analyses, an observational study and a trial/ feasibility study. All studies above sought to study COVID-19 as a disease and to present treatment plans and protocols to address the problems that come as a result of said disease.

Table 1. PCC table.

Population	COVID-19 Patients
Concept	Telerehabilitation
Context	COVID-19 Patients who were hospitalized and had symptoms that were addressable through Physical Therapy

Table 2. (Sample) Characteristics of studies about telerehabilitation in COVID-19.

Title & DOI	Authors/ Year/ Country	Type of digital technology	Research Design	Methodology	Interventions/ Program	Key findings/ Result

Table 3. Characteristics of studies about telerehabilitation in COVID-19

Title & DOI	Authors/ Year/ Country	Type of Digital Technology	Research Design	Methodology	Interventions/ Program	Key Findings/ Result
Remote Rehabilitation for patients with COVID-19 (https://doi.org/10.2340/16501977-2731)	Sakai et, al.[11] 2020 Japan	WIFI-Connected iPads	Single-centre, retrospective, observational study	43 patients, 18 remote & 25 direct. In the remote program, a Physical Therapist would be stationed in a "Green Zone" which was an uninfected area (Nurses' ward) and is able to instruct the patient while they are in the "Red Zone" which was an infected area (Their room). Clinical outcomes were based on the patient's PCR results, mobility scores, Barthel Index total scores.	• Therapeutic Muscle Exercises • Therapeutic Aerobic Exercises • ADL Exercises as tolerated (Direct Rehabilitation)	No adverse effects were noted among remote rehabilitation patients and authors concluded that the method was effective and successful as all remote rehabilitation patients (18 out of 43 total number of participants) were discharged with a mobility score of 10-15 & a Barthel Index Total of 80-90.
Physical Therapy for Hospitalized Patients with COVID-19 inIsolation: Feasibility and Pilot Implementation of Telehealth for Delivering Individualized Therapy (https://doi.org/10.1016/j.arrct.2021.100113)	Turcinovic, et al.[5] 2021 USA	In-Person & iPad	Prospective quality improvement trial of the feasibility and acceptability of a "hybrid" in-person and telerehabilitation platform to deliver PT to hospitalized adults.	39 participants, all with COVID-19 are given in-person & TeleHealth PT sessions according to their functional capacity & their 6-Clicks Activity Measure of Post-Acute Care (AM-PAC) with less functional patients having more in-person sessions. AM-PAC is the primary outcome measure and was used for evaluation before admission and prior to discharge.	Ability-Dependent Intervention (In-Person): • ADL Retraining • Bed Mobility & Transfers • General Ambulation TeleHealth Interventions: • Therapeutic Exercises on tolerable position (Supine > Sitting > Standing) • Deep Breathing Exercises • Balance Exercises (As tolerated) • Strengthening Exercises (As tolerated)	AM-PAC scores of discharged patients were improved when compared to their admission scores; however, was still unable to match their premorbid scores. A hybrid model for COVID-19 rehabilitation is highly feasible leaving patients satisfied with having1 more extra session of PT despite it being conducted through TeleHealth .

Title & DOI	Authors/ Year/ Country	Type of Digital Technology	Research Design	Methodology	Interventions/ Program	Key Findings/ Result
Effectiveness and feasibility of telereha bilitationin patients with COVID-19: a systematic review and meta- analysis (doi:10. 1136/b mjopen- 2022- 063961)	Seid, et al.[12] (2022) China, Spain	Smart phones & video conferencing	Systematic review and meta-analysis of randomized controlled trials (RCTs).	This systematic review and meta-analysis was reported according to the PRISMA (Preferred Reporting Item for Systematic Review andMeta-analysis)	Li, et al.[13] (2021) Telerehabilitation: breathing control and thoracic expansion exercises, aerobic exercise and LMS exercise; 40–60 min per session; 3–4 sessions per week Rodríguez-Blanco, et al.[7] (2021) -1 Home-based rehabilitation: BG: 10 exercises based on the ACBT, daily for 14 days Rodriguez-Blanco, et al.[7] (2021) −2 Telerehabilitation: non-specific toning exercises of resistance and strength, once a day for 7 days Gonzalez-Gerez, et al.[14] (2021) Telerehabilitation: based on breathing exercises	Four studies with 334 patients with COVID-19 were included. The pooled result of telerehabilitation showed statistically significant improvement on 6-minute walking test (MD 75.50; 95% CI 54.69 to 96.30; p=0.48), 30-second sit-to-stand test (MD 1.76; 95% CI 1.47 to 2.04; p=0.30), Borg Scale (MD 2.49; 95% CI 2.16 to 2.83; p=0.28) and level of dyspnoea (MD 6.26; 95% CI 5.42 to 7.10; p=0.66). The overall treatment completion rate was 88.46%, and the most common reason for withdrawal after randomisation was lost to follow-up or uncooperativeness.
Telerehabili- tation improves physical function and reduces dyspnoe a in people with COVID-19 and post- COVID- 19 conditions: a systema ic review (https:// doi.org/ 10.1016 /j.jphys. 2022.03 .011)	Vieira, et al.[15] 2022 Brazil	Delivery through websites, Rehab App smartphone app alongside a telemetry device, video conferencing, smartphone guidance, and supplementary material	Systematic review of randomized controlled trials	This study followed the recommendations of the Cochrane Collaboration Handbook and the Preferred Reporting Items for Systematic Review and Meta- analysis or PRISMA statement.	• Telerehabilitation of any form Gonzales- Gerez, et al.[14] (2021) • Breathing exercise program via website with group exercise in one session per day, seven days a week for one week Li, et al.[13] (2021) • Breathing control, thoracic expansion, aerobic exercise, lower extremity strengtheni ng exercises via RehabApp & monitoring with a telemetry device three to four sessions a week for six weeks	

Title & DOI	Authors/ Year/ Country	Type of Digital Technology	Research Design	Methodology	Interventions/ Program	Key Findings/ Result
					Pehlivan, et al. (2021) • Breathing exercises, active breathing techniques, upper and lower extremity exercises, walking, wall squat exercises via videoconfe rencing synchronized exercise program in three sessions perweek for six weeks Rodriguez-Blanco, et al.[7] (2021) • Resistance exercises delivered via website with one session per day for seven days a week in one week do Amaral, et al.[16] (2022) • Resistance exercise, & aerobic exercise via guidance with a smartphone, with additional supplemen tary material and website. Resistance exercise was done in three sessions per week and aerobic exercise in five sessions perweek for twelve weeks Rodriguez- Blanco, et al.[7] (2022) • Strengtheni ng program via website with one session per day & seven days per week for two weeks • Breathing exercise program via website with one session per day & seven days a week for two weeks.	

Title & DOI	Authors/ Year/ Country	Type of Digital Technology	Research Design	Methodology	Interventions/ Program	Key Findings/ Result
Do patients with and survivors of COVID- 19 benefit from telerehabilita-tion? A meta- analysis of randomized controlled trials (https:// doi.org/ 10.3389 /fpubh.2 022.954 754)	Huang, et al.[17] 2022 China	Delivery through RehabApp smartphone app	Meta- analysis of randomized controlled trials	This study followed the Preferred Reporting Items for Systematic Review and Meta-analyses guidelines. A literature search was conducted in the following databases: Cochrane Library, EMBASE, MEDLINE, PEDro, ClinicalTrials. gov, & WHO International Clinical Trials Registry Platform. The inclusion criteria for studies were: randomized controlled trials with participants such as adults aged ≥18 years with a current or past diagnosis of COVID-19, telerehabilitation as intervention, with rehabilitation delivered at least 50% remotely, with comparison to any rehabilitation delivered face-to-face, within the spectrum of usual care, or waiting without intervention; and the evaluation of at least one outcome regarding physical functions, psychological functions, or quality of life of patients; and limited only to english articles.	Rodriguez-Blanco, et al.[7] (2021) • Non- specific conditioning exercise program with its basis on non-specific toning resistance & strength exercise Gonzalez- Gerez, et al.[14] (2021) • Remote respiratory rehabilitatio n with web- based breathing exercise program, specifically: active cycle breathing techniques Rodríguez- Blanco, et al.[7] (2022) • Web-based breathing exercise program specifically active cycle breathing techniques • Web-based strength exercise program Li, et al.[13] (2021) • Unsupervis ed, three- tiered, six week home exercise program with emphasis on breathing control, thoracic expansion, aerobic exercise & lower extremity strengtheni ng and scheduled increase of difficulty & intensity over time Philip, et al. (2022) • Six week online program focused on breathing and wellbeing Wei, et al. (2020) • Internet- based integrated program including self help interventions, breath relaxation techniques, mindfulness techniques, & butterfly hug method	The stated evidence in this studywere of moderate- to very low- quality and may be considered as an effective and safe intervention for patients with COVID-19 as well as survivors of the disease in terms of addressing dyspnea, lower extremity muscular strength, ambulation capacity, & depression .

Title & DOI	Authors/ Year/ Country	Type of Digital Technology	Research Design	Methodology	Interventions/ Program	Key Findings/ Result
					Liu, et al.[13] (2021) • Computerized cognitive behavioral therapy with emphasis on relaxation, mental imagery training, mindfulness techniques, & meditation	
Short-term Effects of a Conditioning Telerehabilitation Program in Confined Patients Affected by COVID-19 in the Acute Phase. A Pilot Randomized Controlled Trial (doi: 10.3390 /medicin a57070 684.)	Rodriguez-Blanco, et al.[7] (2021). Spain	Smartphone & video conferencing	The pilot trial design was a randomized, controlled, parallel, double-blind, two- arm clinical trial of treatment	The study consisted of a sample size of 36 patients, 18 in the intervention group while the other 18 were in the control group who did not perform any physical activities. Both groups were assessed with the use of a 6MWT, 30 Seconds Sit to Stand Test (30STST), and the Borg Scale of Perceived Effort.	Non-specific Conditioning Exercise Program "10 exercises based on non-specific toning exercises of resistance and strength to try to improve the physical deconditioning and physiological deterioration that implies." (Exercises can be found in the link: https://www. fi siosurid.com/ ejercicios- proyecto-covid/	There were significant improvements in the Borg Scale (p<0.001), 6MWT (p=0.026), and 30STST of the Exercise Group when compared to the Control Group.
Short-term effects of a respirat ory telerehabilitation program in confined COVID-19 patients in the acute phase: a pilot study. (doi: 10.3390 /ijerph1 814751 1)	Gonzalez -Gerez, et al.[14] (2021). Spain	Video conferencing	The pilot trial design was a randomized, controlled, parallel, double-blind, two- arm clinical trial of the treatment.	40 participants were randomly assigned to one of two groups: an experimental group that received pulmonary rehabilitation and a control group that did not participate in physical activity. The one-week intervention was completed by 38 individuals, 19 in each group. They used the 6- Minute Walk Test (6MWT), Multidimensi onal Dyspnoea-12 (MD-12), Thirty- Second Sit- To-Stand Test (30STST), and Borg Scale to collect data.	Breathing Exercise Group "10 exercises based on non-specific toning exercises of resistance and strength to try to improve the physical deconditionin g and physiological deterioration that implies." (Exercises can be found in the link: https://www. fi siosurid.com/ ejercicios- proyecto-covid/ In addition, Active Cycle of Breathing Techniques was added to help patients improve their breathing as a result of being more able to clear mucus from their lungs.	The study found that patients in the experimental group saw statistically significant changes compared to the control group in all variables evaluated (Borg Scale Difference: p<0.001; MD-12 Difference: p<0.001; 30STST Difference: p=0.001; 6MWT Difference: p=0.007), with magnitude effects that were substantially larger than those observed in thecontrol group, demonstrating the intervention's clinical relevance. However, the small sample size and brief follow-up in this study restrict the findings' generalizability.

Title & DOI	Authors/ Year/ Country	Type of Digital Technology	Research Design	Methodology	Interventions/ Program	Key Findings/ Result
Cardiovascular, respiratory and functional effects of tele-supervised home-based exercise training in individuals recovering from COVID-19 hospitalization: A randomized clinical trial. (https:// doi.org/ 10.1101 /2022.0 1.24.22 269745)	do Amaral, et al.[16] (2022). Brazil	Smartphone & Video conference platform, phone calls, WhatsApp	Randomized, single center and single- blinded clinical trial	Thirty-two individuals (52 ± 10 years; 17F) randomly assigned to exercise (N = 12) and control groups (N = 20), had their anthropometric (weight, body mass index), hemodynamic (brachial and central blood pressure), vascular (arterial stiffness), ventilatory (pulmonary function and respiratory muscle strength), and functional parameters (handgrip strength, five- time sit to stand [FTSTS], timed up and go test [TUG] and six- minute walking test [6MWT]) assessed at baseline (30 to 45 days of hospital discharged) and after 12 weeks of follow-up.	The telesupervised exercise training program consisted of three 60-minute sessions per week for a total of 12 weeks. The program included aerobic exercises such as walking and/or cycling (depending on preference and equipment availability) as well as resistance exercises (Warm up, bodyweight squat, wall pushups, bodyweight lunges, one- arm rows, deadlift, side lateral raise/shoulder press, elbow flexion, calf raise, and abdominal crunch in chair) using the patient's body weight, resistance bands, or water/sand- filled plastic bottles that were tailored to the participant's functional capacity and monitored via wearable devices.	Both the Exercise and Control groups had an improvement in symptoms, increase in body weight, improved FEV1 and FVC%, handgrip strength, SpO_2 at the exercise phase of 6MWT; however, only the Exercise Group had significant improvements in the following as compared to the control group: 1) quantity of persistent reduction of symptoms, 2) Increased Resting SpO_2 & Reduced Pulse Wave Velocity, 3) Increased Maximal Inspiratory Pressure & Maximal Expiratory Pressure, and 4) Increased Heart Rates in both exercise and recovery phases of 6MWT. However, the study had a limited sample size, and the individuals were relatively young and had mild to moderate COVID-19 disease, limiting the findings' generalizability.
Effect of progressive muscle relaxation as an add-on to pulmonary telereha bilita-tion in discharged patients with COVID- 19: A randomised controlle trial. (doi: 10.1016 /j.ctcp.2 023.101 730)	Hajibashi A, et al.[18] (2023) Iran	Videos and descriptions through WhatsApp messenger. Video calling. Adherence assessed through texting.	Assessor-blinded randomized controlled trial with two parallel treatment arms	52 patients in total (26 in Experimental group & 26 in Comparison Group) were assessed through the following Outcome Measures: 6MWT; Persian Version of the Fatigue Severity Scale (FSS); Pittsburgh Sleep Quality Index (PSQI); Hospital Anxiety and Depression Scale (HADS) 36-item Short- Form Health Survey (SF- 36), and St. George's Respiratory Questionnaire (SGRQ).	Both the EG and CG both had Pulmonary Telerehabilitation; however, only the EG had an addition of Progressive Muscle Relaxation in the management. The PTR consisted of breathing exercises: Diaphragmatic Breathing, Chest Expansion, Pursed-Lip Breathing, and deep breathing with arm movement - 10 repetitions x 3 sets.	Both groups and their interventions have shown to be highly effective in improving all the aforementioned outcome measures; significant improvements in 6MWT, FSS, PSQI, HADS, SF- 36, & SGRQ. However, significant differences arose between the two groups in Sleep Quality (PSQI), and Anxiety/De pression (HADS).

Title & DOI	Authors/ Year/ Country	Type of Digital Technology	Research Design	Methodology	Interventions/ Program	Key Findings/ Result
					PTR also included strength training: Squats, Standing Heel-Rise, Shoulder Abduction, Shoulder Flexion, Shoulder Horizontal Adduction and Extension, and Elbow Flexion/ Extension - 10 Repetitions x 3 sets x 2-min rest in between sessions. Aerobic Exercises were also used which included walking and upper-limb exercises whose intensities should match an intensity of 3-4 on the Borg Scale. The EG made use of the program above but also included PMR exercises which had the following: contraction of 5-7s and relaxation 30-40s of the 16 main muscle groups.	

Telerehabilitation Delivery and Technologies

Table 3 presents all the data with Column 3 presenting the method/type of monitoring and treatment delivery used in each study. A majority of the studies made use of any form of internet connected device that is able conduct video conferencing. Studies such as do Amaral, et al. (2022)[16] & Hajibashi, et al. (2023)[18] specifically made use of WhatsApp as a method of communication. Other studies did not describe the specific applications used. Studies by Rodriguez-Blanco, et al. (2021)[7] and Gonzalez-Gerez, et al. (2021)[14] also delivered the exercise instructions through the use of a website that demonstrated how to perform said exercise plan (https://www.fisiosurid.com/ejercicios-proyecto-covid/). The second most common form of monitoring and treatment delivery was through the use of a Smartphone Application. Despite not being a "Rehabilitation" specific application, the way do Amaral, et al. (2022)[16] made use of WhatsApp would still be considered delivery through Application. There are a few studies that specified the use of an iPad as the device; however, Turcinovic, et al. (2021)[5] also made use of an in-person approach to treatment delivery among more critical patients. In terms of monitoring, a study made use of a Chest-Worn Heart Rate Telemetry Device to monitor the patients' heart rates during exercise. Other studies on the other hand made use of a smartphone application to measure the number of steps made when performing a 6-Minute Walk Test. Both Rodriguez-Blanco, et al. (2021)[7] and Gonzalez-Gerez, et al. (2021)[14] made use of the StepsApp for this very purpose. The other studies however tested

their baseline values before and after the treatment plan was completed in an in-person manner.

Treatment Protocol

The most common Physical Therapy Management used was Therapeutic Muscle Exercises (Strengthening) interestingly enough. The second most common management was both Deep Breathing Exercises/ Chest Expansion and ADL Retraining which was present in 4 out of 9 studies. Aerobic Exercise was the fourth most common management. Both ADL Retraining and Gait Retraining were both present in two different studies while Balance Retraining was included only in one study. Another single treatment plan was Progressive Muscle Relaxation.

Among the 9 studies, the most commonly used Outcome Measure was the 6- Minute Walk Test. The second most commonly used outcome measure among the studies listed in Table 3 is the 30-Second Sit to Stand Test. Outcome Measures such as Borg Scale of Perceived Effort were each used twice among the listed studies. Other outcome measures such as Mobility Scores, Short Form 36, Barthel Index, 6-Clicks Activity Measure of Post-Acute Care, Exercise Tolerance Questionnaire, Static Squat Test, Anthropometric/Hemodynamic/Vascular/Ventilatory and Functional Parameters, and Timed Up and Go Test were all used once in all of the listed studies.

Baseline Findings and Treatment Results

A majority of the listed studies consisted of sample sizes below 50. There was one study that had a sample size greater than 50.

All 9 articles have statistically significant evidence that their telerehabilitation protocol is effective in addressing the symptoms and QOL of COVID-19 patients; however the basis of improvement varies among the studies. A majority of the non-systematic review and meta analysis studies are Randomized Controlled Trials and have found that the telerehabilitation groups have significantly better outcomes than the control group, most of which did not receive any form of treatment (3 Studies) (Table 2). Only one study did not have a control group; however, found significant improvements in the outcomes of the patients' pre-intervention state compared to their post-intervention results. One study stood out however, as Turcinovic, et al. (2021)[5] were able to garner the premorbid results of their patients through a self-reported activity measure. Within this study, there was still an improvement in the patients' condition when comparing their morbid scores and post- intervention scores; although, the post-intervention scores were unable to match their premorbid scores.

DISCUSSION AND CONCLUSION

This scoping review's purpose was to map out the current literature that surrounds the telerehabilitation protocols of COVID-19 patients; particularly; the methodology, treatment protocols, and descriptive data of each. The authors were able to identify 9 studies, 4 of which were from first-world nations, that match the inclusion criteria required by the scoping review.

Interventions

Pulmonary Rehabilitation is defined by the AARC Clinical Practice Guidelines for Pulmonary Rehabilitation as "multi-disciplinary program of care for patients with chronic respiratory impairment that is individually tailored and designed to optimize physical and social performance and autonomy". The rehabilitation methods used in the studies listed in Table 3 show that there are a wide variety of exercises, and protocols that would significantly improve the patient's condition if the method matches the patient's need. As mentioned previously, Strengthening exercises stand as the most common treatment protocol among the studies listed with Deep Breathing and Chest Expansion Exercises being the second most common followed by Aerobic Exercises. These findings stand relatively in line with the systematic review of Seid, et al. (2022)[12] which found Aerobic Exercise & Muscle Strengthening Exercises as the most common intervention programs for patients recovering from respiratory tract infections. They did not however specify how much exactly the difference is between the two, but the current scoping review agrees with their common findings. Intervention programs for COVID-19 primarily consist of Breathing Exercises conducted in a home setting were common among the listed studies/articles.

Traditionally, treatment protocols for respiratory diseases such as COVID-19 would primarily focus on Deep Breathing Exercises and Aerobic Exercises to address dyspnea and improve cardiopulmonary ability respectively. However, this current review

has shown that strengthening was the most common treatment modality. This perhaps would help address and further prevent muscle weakness as a result of COVID-19 and does not result in dyspnea much like aerobic training according to the WHO (2020).[18 19]

Deep Breathing Exercises constituted a large part of COVID-19 rehabilitation as it immediately addresses the dyspnea present in all cardiopulmonary diseases. Exercises such as these helps address the anxiety and breathlessness that comes with said diseases (WHO, 2020).[19]

Outcome Measures

This current review has also successfully mapped out the outcome measures used by the 9 studies. The tested protocols and interventions provide the appropriate context and evidence to their overall efficacy to the involved COVID-19 patients.

Clearly, the most common outcome measure used was the 6 Minute Walk Test (6MWT) as it provides a functional, therapeutic response, and prognostic data that is valuable in the care of patients with respiratory as well as cardiac diseases. It is used widely due to its simplicity and reproducibility, delivering a consolidated image of the cardiopulmonary and musculoskeletal response to exercise." as described by Casano & Anjum. (2022).[20] They also cited its ease of use; that it does not require any special training to appropriately implement and that it is a very safe and well-tolerated test for patients at any stage of treatment. Some clinicians also make use of the shorter version - 2-Minute Walk Test if patients are unable to perform the 6MWT as a result of their condition.

This is then followed up by the repeated use of the 30-Second Sit to Stand Test (30STST) and is likely common for the same reasons as the 6MWT: Easy to execute, clear interpretation, does not require further training, and is a very safe test even among more seriously affected patients. With that, it is a terrific and effective measure for assessing lower extremity functional strength among patients. The other common outcome measures such as the Short Form 36, Borg Scale of Perceived Effort, and Dyspnea-12 were each used twice among the listed studies because of their effectiveness in measuring the quality of life of the patients, their level of effort and exhaustion before and during treatment, and their level of shortness of breath as a result of their condition, respectively. These studies are understandably popular as they provide the researchers with the subjective perspectives of the patients regarding their current condition.

Presentation of Systematic Reviews on Available Protocols

Knowing both the most common interventions and the most common methods of measurement provides the appropriate context required to describe why they are common in the first place. With that, the 3 interventions have been proven to be significantly effective as described by the findings of Huang, et al. (2022)[17] and their meta-analysis on various RCTs surrounding COVID-19 telerehabilitation. Their analysis presented with sufficient data favoring the efficacy of the 3 most common interventions: Strengthening (Particularly of the lower extremities) conducted through telerehabilitation and measured by the 30STST was supported by their analysis; the efficacy of Deep Breathing Exercises conducted through telerehabilitation and measured through the Borg Scale & Multidimensional Dyspnea-12 Questionnaire have shown to be a statistically effective method of improving dyspnea among COVID-19 patients; and finally, ambulation ability was also assessed through the popular 6MWT and addressed with Aerobic Exercises conducted through telerehabilitation was also favored by the authors in improving 6MWT scores. With regard to other interventions meant to address other factors, specifically Depression, Anxiety, and Quality of Life, the meta-analysis of Huang, et al.[17] explained that the evidence either was low-quality or had no evidence of superiority of telerehabilitation compared to usual care.

Telerehabilitation: A Protocol for the Wealthy?

Telerehabilitation in theory would allow patients with varying conditions such as musculoskeletal, neurological, and cardiorespiratory dysfunctions to perform their rehabilitation within the comfort of their home and would help patients limit large hospital costs as suggested by Marti, et al. (2021). Although the mentioned studies have presented the benefits of telerehabilitation in the context of efficacy, they have not expressed the effectiveness of telerehab as a cost-effective approach to both hospitals and patients. This trend was also noticed by Huang, et al. (2022)[17] where they noted that none of the studies used in their meta-analysis described the potential cost-effectiveness

of telerehabilitation when compared to traditional rehabilitation protocols. Turcinovic, et al. (2021)[5] was able to reference the cost savings garnered by patients who have advaned cancers, even leading to decreased hospitalizations. Despite this referencing, their study did not make any conclusions referring back to cost-saving and cost-effectiveness of telerehabilitation.

Seven of the 9 studies were conducted in "Industrialized Nations" - Industrialized as described in a Dictionary of Environment & Conservation by Allaby & Park. (2012).[20] The lack of studies from developing nations stem from a large number of barriers as described by Alemayehu, et al. (2018).[21] Lack of Financial and Human Capacity; Ethical and Regulatory System Obstacles; Lack of Research Environments; etc. Other than these, poorer nations lack the resources necessary to develop the infrastructure required for telerehabilitation. Patients in said nations also do not always have the money and equipment required for the telerehabilitation program and the necessary technologies behind them. It was described by Aloyuni, et al. (2020)[22] that the introduction of telerehabilitation-based physical therapy has barriers, specifically: technical issues, staff skill problems, and lack of resources in the high-cost introduction of telerehabilitation in health care settings. Added to that, Jafni, et al. (2018)[23] explained that the readiness of a rehabilitation center in adapting to online services can be significantly affected by poor network connectivity, lack of exposure to e-healthcare knowledge, and the lack of awareness on how to use hardware and software. D'Souza (2021)[24] mentioned possible barriers such as lack of training and connection between the information and communication technology experts. Despite these, he still sees the potential benefit that telerehabilitation can have to the overall healthcare system if these barriers were addressed appropriately.

Patient - Healthcare Worker COVID-19 Transmission

All 9 studies emphasized in their introduction the benefit that telerehabilitation has on healthcare workers - theoretically, the minimized face-to-face contact of infected patients to healthcare workers, specifically physical therapists, would significantly reduce the likelihood of cross-infection when compared to a full face-to-face physical therapy program. The study by Li, et al. (2021)[13] mentions that "... delivery of conventional inpatient or outpatient rehabilitation is complicated through diminished capacity in post-acute care as well as clinical and public health measures imposed to reduce the risk of viral transmission. Telerehabilitation provides a viable alternative that could be superior to no rehabilitation and as effective as conventional rehabilitation." emphasizing a safer alternative minimizing risk of viral transmission. Rodriguez-Blanco, et al. (2021)[7] also shared the same sentiments of minimizing risk of infections stating "… traditional rehabilitation has involved human interaction and physical contact, leading to increased transmission and contagiousness. To face this problem, telerehabilitation has increased in importance.". Gonzalez-Gerez, et al. (2021)[14] are also in direct support of the proposition, as they find it necessary to develop a randomized, controlled trial to assess the effectiveness of breathing exercises in isolated patients with mild to moderate COVID-19. Telerehabilitation has become an exciting option to manage these patients. It has been recognized as an essential component of respiratory exercises, as it allows access to patients who would benefit from rehabilitation while minimizing human-to-human contact.

Despite the overwhelming amount of studies emphasizing the reduced risk of patient-healthcare professional cross-infection, none of the studies have delved deeper into providing the necessary evidence this claim. There is still a lack of statistical evidence that proves that "Telerehabilitation is an effective method of minimizing patient to physical therapist transmission and contagiousness". In which case, it would be a recommendation to future researchers to add this specific approach to studies leaning towards telerehabilitation.

CONCLUSION

There are numerous researches on the use of telerehabilitation of COVID-19 patients; but very few among developing nations. A majority of the studies made use of Strengthening Exercises, followed by Deep Breathing Exercises, and Aerobic Exercises. Individually, all the studies reviewed have had significant improvements in outcomes when comparing a telerehabilitation program to a control. References such as the systematic review of Huang et al (2022) have statistically proven that there are significant improvements among COVID-19 patients with regard to Lower Limb Strength (Improved 30STST scores), Dyspnea (Improved Borg Scale), and Aerobic/ Endurance Capacity (Improved 6MWT scores). Despite this, gaps in literature, specifically the lack of studies

conducted in developing nations, unevidenced claim of "Better cost-effectiveness" and "reduced risk of infection" are consistent in all studies and would be beneficial if addressed by future studies. In totality, there is evidence that supports the effectiveness of telerehabilitation of COVID-19 patients.

Limitations of the Study

This study benefits the body of knowledge surrounding the telerehabilitation of COVID-19 by shedding light and listing the available protocols, interventions, measures, and results of the 9 listed studies. By design, the study is a scoping review; thus, did not critically appraise each screened literature and cannot create its own conclusions, specifically towards the direction of determining exactly what the most effective interventions are, what outcome measures should be used, and what outcomes would the interventions result to. The study also did not take into account the specific sample demographics of the studies reviewed. Specifically, it did not document age ranges and gender. It also does not document the possible longer-term effects of each study. The studies were also not assessed for possible risks of bias, which understandably prevents the production of specific, accurate, valid, and reliable conclusions between all listed studies. With the significant differences between all the studies and also a general outlining of each study, the authors recommend readers to follow Table 3 with a perspective of seeing each study as separate and with no comparisons among them.

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