

Physical exercise program during the COVID-19 pandemic for stroke survivors: an intervention development study

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ABBREVIATIONS

ETNS Electromyography-triggered neuromuscular stimulation
SARS-CoV-2 Severe Acute Respiratory Syndrome Coronavirus 2

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BACKGROUND: To mitigate the COVID-19 pandemic, social isolation was needed. Since individuals after stroke have a high risk if catching the COVID-19, and physical exercise is one of the most effective treatments for the disease. Staying physically active through a remote exercise program is an appropriate solution to minimize the inactivity effects.

AIM: To report the process of development of a remote physical exercise program based on a face-to-face physical exercise program.

METHOD: We developed the remote physical exercise program, maintaining the structure of the face-to-face version. Two weeks under social isolation, the remote physical exercise program has started. For the first 2 weeks, for familiarization purposes, we have provided the participants with only a few parts of the session followed by a test session in a synchronous mode of delivery. From the third week onwards, the activities were fully developed.

RESULTS: An asynchronous remote physical exercise was chosen to ensure that the individuals would be able to perform the physical exercises with a caregiver or family member at home, as safe as possible. The sessions were delivered by a single video with all five components, including the parameters of prescription (time, sets, and repetitions), safety instructions, and alternatives exercises. We created two questionnaires to investigate attendance, barriers, safety, and overall experience.

CONCLUSION: This paper purposed an asynchronous remote physical exercise program with a single video per session to initiate telemonitoring for stroke survivors, who had already participated in a face-to-face program of physical exercise before the COVID-19 pandemic.

KEYWORDS: Stroke | Physical exercise | Telemonitoring | COVID-19 | Rehabilitation

INTRODUCTION

At the end of 2019, a new respiratory disease named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) or (2019-nCoV), with unknown origin, spread from China to other countries ¹. To contain its fast spread and transmission, social isolation was implemented to minimize new cases ^{1,2}. Governmental mitigation measures to control this pandemic interrupted face-to-face rehabilitation programs, particularly affecting neurological patients.

Stroke is a common neurological disease which presents significant morbidity and mortality in the world ³. Stroke survivors often experience physical decondition, having a sedentary lifestyle that impacts how they perform daily living activities ^{4,5}. This condition increases the risk of falls and the recurrence of stroke ⁶. Thus, physical activity is important to prevent new stroke events, to restore body functions, and to influence multiple physical and psychosocial domains after stroke ⁶.

Telerehabilitation has arisen as a feasible possibility to provide and monitor physical activity to stroke survivors during the pandemic. Few studies have been

conducted to investigate the effectiveness of remote physical exercise protocols. However, those studies include only one patient at a time ⁷⁻⁹ and required a specific technological equipment (e.g., electromyography-triggered neuromuscular stimulation (ETNS) ^{8,10} or a Kinect ⁹) for reading the data on muscle contraction and movement direction respectively. This mode of delivering the intervention proved to be safe and able to address the patients' needs however it is not applicable in the reality of the COVID pandemic. The protocol proposed by Pui Kei et al 2020 ¹¹ does not require specialized technological equipment. It requires a mobile phone, a notebook, or a tablet, and it is performed in the asynchronous mode of delivery with an exercise database available online to the patient. This protocol followed the specific recommendations for exercise prescription after stroke proposed by Billinger et al., 2014 ¹². The program was effective and aimed to improve muscle strength, balance, and gait ability ¹¹. Given the reality of social distancing and the need to adapt physical exercise protocols to the online model, it was urgent to convert the in-person group-based physical exercise program to the remote mode of delivery ^{7, 9, 11,14}.

A recent meta-analysis ¹⁵ raised questions about how effective is telemonitored rehabilitation compared to conventional rehabilitation for stroke survivors. The authors have found low-quality of evidence with no difference in effects between telerehabilitation and physical therapy programs (based on only two studies). Thus, telemonitoring with a home-based physical exercise program demands more investigation. Our study developed a protocol that builds the rationale for a remote physical exercise program based on a face-to-face model. We presented information related to the purpose, strategies, and clinical rationale to develop an online physical exercise program tailored to stroke survivors.

MATERIAL AND METHODS

This study was approved by the Human Ethics Committee (Reg. No. 4.119.009; CAAE No. 32005420.4.0000.5391) and the GUIDED checklist was used to conduct the study ¹⁶. This was conducted at the Motor Behavior Laboratory of the School of Physical Education and Sport of the University of São Paulo, São Paulo, Brazil.

Interventions

Face-to-face program

In 2014, a face-to-face program set-up was developed at the School of Physical Education and Sport at the University of São Paulo, Brazil. This program aims for stroke survivors to do functional activities and to improve their social participation ¹⁷, attending a 60-minutes class twice a week ¹⁸. The specific aims of the physical exercise program are 1) to prevent sedentary lifestyle; 2) to prevent falls and the fear of falling; 3) to keep or improve functional capacity; 4) to promote social interaction between peers; 5) to stimulate experience sharing and to support their acceptance, development, and adaptation processes after stroke.

The development of a remote physical exercise program via telemonitoring

As soon as the face-to-face program activities were suspended, due to the sanitary restrictions to constrain the pandemic, we took two weeks to develop our remote intervention strategies, while we were inquiring the potential participants regarding their

internet connection availability, and announcing the switching to the remote mode of delivery. Figure 1 illustrates the steps to develop and implement this program.

5-Steps

To develop the remote physical exercise program

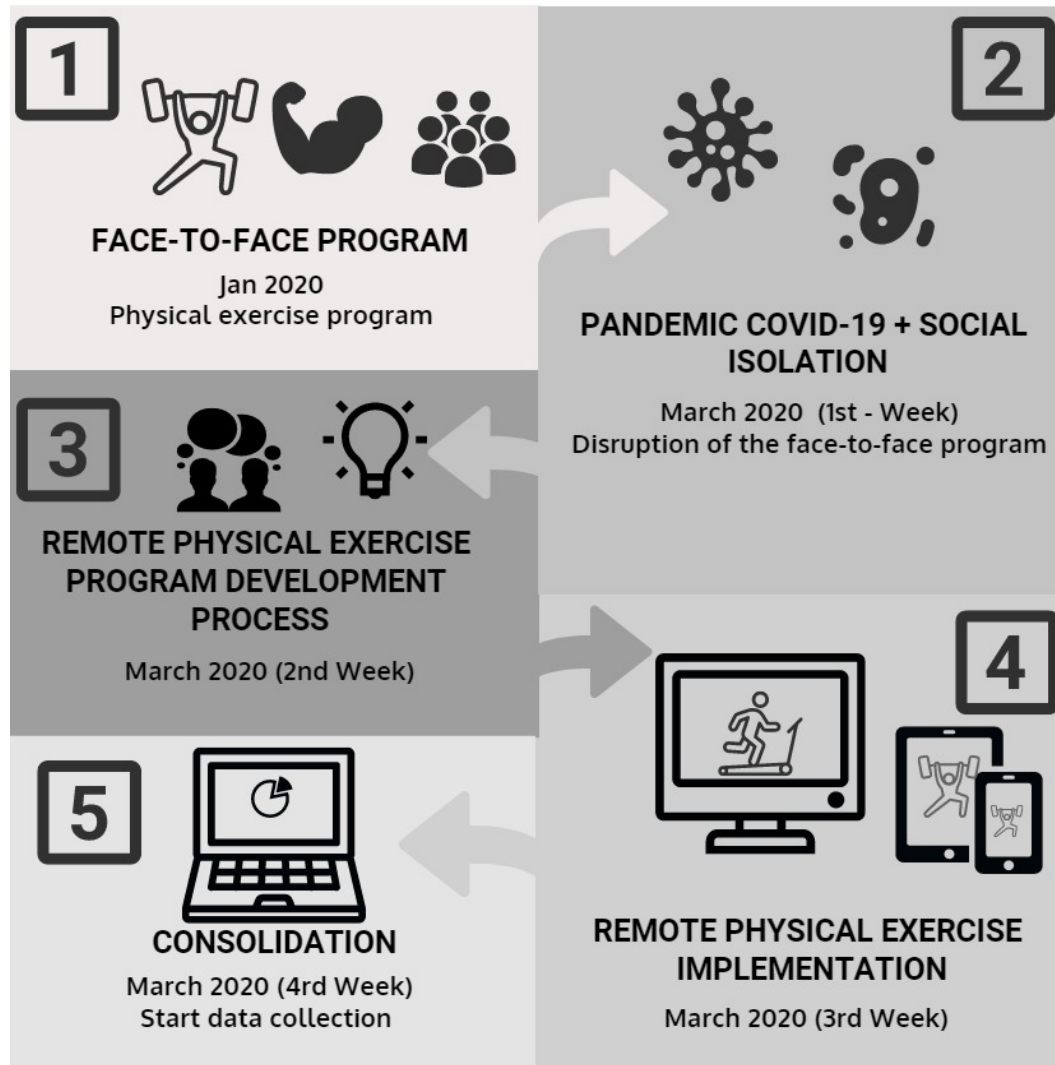


Figure 1. Steps of the remote program development

In the first week, the participants received a text message with a guideline to support the physical exercise activities. This guideline held information about how to safely exercise and stimulate the cardiovascular, respiratory, muscular systems, and cognition functions. The team was composed of a team leader (faculty member), a physical education instructor (faculty member), a health instructor team (four graduate students and, an in-charge person to supervise the intern team), and an intern team (20 undergraduate

students). The team also set the: strategies up and discussed safety, adherence, motivation, individual needs, human resources, and technological resources. Based on the motor and cognitive characteristics of stroke survivors, the team has decided that the remote physical exercise program should follow a similar model to the face-to-face program to assure: 1) full mental and health development; 2) that the same goals and weekly attendance as the face-to-face program would be kept; and 3) safety and physical integrity of participants.

In the second week, the participants received a short version of the session as a transition to the online intervention model. From the third week onwards, the online activities were fully offered. During these two weeks, all remote activities were synchronous to test the feasibility to stream the exercises sessions, to check the participants' skills with technology, their ability to connect and to receive the videos, and how safely the participants would be by practicing exercises at home. After this trial, based on cognitive impairments, issues with technology, and lack of knowledge to manage mobile phones and computers, we have realized that the live streaming was not the best option for many of our participants. Therefore, we shift to the asynchronous model.

RESULTS

In Table 1, information about the face-to-face program version and remote program version is described.

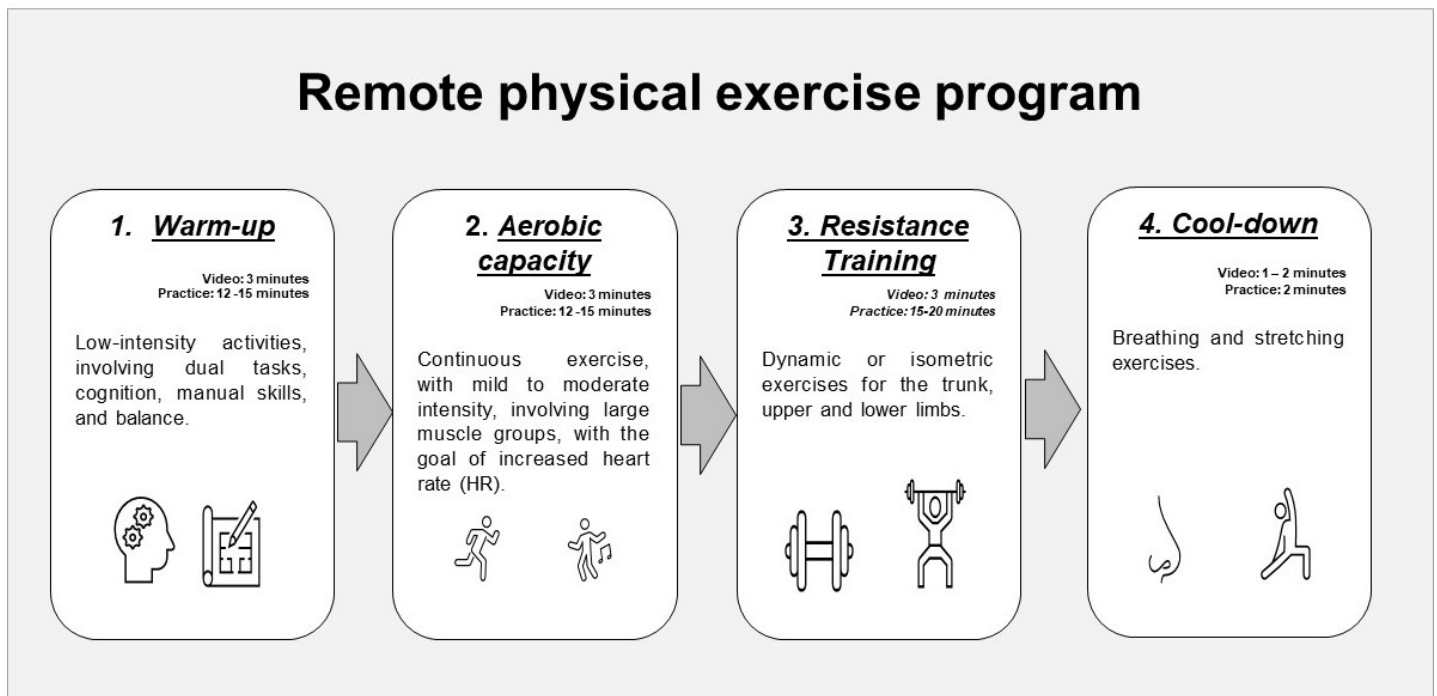


Figure 2. Part of the sessions of the face-to-face and the remote programs.

For safety and motivation reasons, we developed three actions to support each video session: 1) To text message each participant to ensure that they were able to perform a session; 2) To ask them whether they need a video meeting to perform a

session; 3) to ask the participants to record their performance and send it to the instructor to receive feedback. Each video session aimed to challenge and to supply safety to the participants when they would exercise at home. There was a concern to choose activities with diverse levels of complexity and difficulty to offer the proper challenge to each participant.

We have decided to keep the same structure applied in the face-to-face program. Eight to ten minutes videos were recorded (Table 2) and shared twice a week, with instructions for each part of the session.

Table 1. Information that was part of the different video's parts

Part of the session	Content of the video
Warm-up	Practice time for each task. Presentation of levels of complexity. Possible interurrences during the task (memorization difficulties).
Aerobic capacity	Safety rules: work close to support, in a safe and adequate environment. Prescription: suggestion of moderate and continuous activity (Borg 12-15), activity time (12 to 15 minutes). Intercurrences during the practice (imbalances, extreme tiredness) and precautions to take.
Resistance Training	Prescription (overload, number of series, and repetitions). Guidelines for postural alignment and execution of the exercise. Exercise alternatives, in case of joint pain or discomfort).
Cooldown	Prescription (practice time). Guidelines for postural alignment and execution of the exercise Exercise alternatives, in case of joint pain or discomfort)

To monitor the participants engagement to the program, the team developed a survey to measure how often participants performed the sessions, how many adverse events (i.e., pain, dizziness, nausea, fear, or insecurity to perform any exercise, or falls), how they felt during and after a session, and the participants' overall experience to participate in the remote program. All information was surveyed by a weekly telephone inquire. Additionally, the participants should answer monthly their personal experience about the program. This monthly questionnaire included a perception scale about their overall experience related to the remote program (i.e., mode of delivery and format, safety, adequacy of exercises, communication with the team, effectiveness, social support from the team), self-perception of health, and relationship with family members, including questions addressed directly to the caregiver or family member.

DISCUSSION

The purpose of this study was to report the process to develop a telemonitored home-based physical exercise program inspired in a face-to-face physical exercise program for stroke survivors. We have provided the context and a clinical rationale to switch from a face-to-face to a remote physical exercise program. Telerehabilitation programs have been carried out as a therapeutic option for more than a decade ¹⁵. However, in Brazil, this mode of delivery was not a common option and not allowed by national agencies (particularly the physical therapy one). The need to maintain physical

activity even with the social distancing imposed by the COVID-19 pandemic meant that all the health teams had to review the mode of delivering physical exercise protocols. Under the COVID-19 pandemic constraints caused by the social distancing requirements, there was a need to keep stroke survivors away from a sedentary lifestyle, therefore our remote program arose as support and guidance actions for these people^{18,19} activity). Physical exercise is paramount to control symptoms and prevent a new stroke event, and such effort was mandatory. It is a challenge to find the proper technology to fit the needs of stroke survivors. We urged to develop a physical exercise program that was accessible, feasible and could provide educational, physical, and emotional support to the stroke survivors. The mode of delivery should be feasible, affordable, and technologically available to cover the stroke survivor's needs in Brazil. Mainly, the main characteristics of this sample include adults, of low income, of medium education²⁰. Some issues were taken into consideration to develop this remote physical exercise program: the need of delivering a short video (due to internet connection constraints) including all the explanation and details to perform the exercises; to adjust the language to provide content on how to perform and how to assist the participant, in a simple and straightforward language for the participant and their family member or caregiver; to provide information about how to select the appropriated place (environment) to exercise and to adapt the use of home-based materials to practice the exercises; to select the appropriated exercises to stimulate motor, sensory and balance impairments; to include in the protocol the appropriated exercises to stimulate the cardiorespiratory system efficiently even without a direct cardiac monitoring, such as it was done in the face-to-face model^{15,21}.

Participants' feedback was a key-aspect to manage the expectations provided due to the switching from a face-to-face program to an actual remote program. Strategies should be flexible to continuously provide adjustments in the protocol. Thus, by the end of each session, the research team discussed these questions: 1) Are the sessions accessible and easy to understand? 2) Are the exercises pleasant and capable of motivating the participants? 3) Do the exercises include various levels of complexity to encompass from mild to moderate impaired stroke survivors? 4) Are the exercises safe and preserve the individual's physical integrity? 5) Do the sessions properly stimulate (intensity, volume, practice time, type of exercise) the various systems of the body? The video content was weekly developed and recorded. Therefore, we were able to address the participants' needs on time, including their feedback to improve the next weekly session. This personalized outcome strategy is also used in our face-to-face programs and has shown a significant impact on the adherence rate to the exercise program as showed by Kimberley et al²².

There are many issues involving such remote mode of delivery to meet stroke survivors' needs and involve those individuals in the practice of regular exercise. Considering that the stroke population is heterogeneous, regarding the time, magnitude, and diversity of impairment, this may impact the remote physical exercise program in groups¹¹. One strategy to overcome this barrier is to carry out the intervention by a multidisciplinary team¹⁵. This premise was used in our study and during the entire process of adapting the activities (previously included in the face-to-face physical exercise program). This adaptation was carried out by physiotherapists, physical education professionals, physicians, and students in these areas. The purpose was to offer to the individual the face-to-face program experience reproduced at home. Adherence, barriers to adherence, safety, and program satisfaction were evaluated and are showed in another

study by the group ²⁰. The remote exercise program had a high adherence rate, and the main reported barriers involved the need to individually tailor the exercises to personal impairments. Attending a remote physical exercise program was safe, and the satisfaction of the participants and their family members/caregivers were positive ²⁰.

Remote monitoring of physical exercises is challenging. The first challenge was to deal with the uncertainty of a remote care model ¹⁵ effectiveness. For example, which model of delivery is better suitable: a synchronous or asynchronous one? The synchronous model of delivery has the professional advantages of being able to observe the participant's performance and provide specific feedback or online adaptation and promote interaction among participants ⁸. On the other hand, it requires a stable internet connection in a specific time, for both the professional and the participant. Also, caregivers need to adjust their routine to monitor and support the participant. Besides, it requires more staff members online to help all the participants properly in group exercises, it requires proper device positioning (i.e., computer, tablet, or smartphone) and adjusts during the session according to each exercise.

Our decision was based on related factors and characteristics of the asynchronous model of delivery for stroke survivors. The advantages of the asynchronous method are that caregiver and participants can perform the session whenever and wherever they want; the participants can decide on the session along the week or distribute it in short bouts along the day; it does not require an internet connection at a specific time and one professional can help many participants. This method was also used by another exercise protocol for groups and proved to be safe and feasible ¹¹. Additionally, they would need a family member to support and the asynchronous model allows time flexibility to adjust their schedule availability to perform the exercises with supervision ¹¹. The disadvantages of the method are: the need of personal commitment, the participant is free to take long breaks, which can impair achievement the prescribed intensity, it takes more time to record and edit the video, it requires the participant to download and store the video. There are a variety of studies in the literature, including different models of delivery of the telemonitoring exercise program. Ghorbel et al ⁹ performed movement analysis of a combined program (synchronous exercise sessions and therapist-assisted exercise sessions), in which a motion sensor (Kinect) was used to provide feedback from the patient to the therapist on the direction of movements and postural adjustments needed during the movement. Chen et al ¹⁰ also chose the synchronous model and used a skin electro stimulator to receive muscle contraction signals and assess whether the patient was performing the movement properly. Chen et al ¹⁰ raise the discussion regarding the different ways to offer telemonitoring. Definitively, we still lack information on the best way to deliver the remote physical exercise protocol.

Pui Kei et al ¹¹ used the asynchronous model of delivery and it is the protocol that most resembles with the one proposed in our study. They made available a database of exercises to the participants. The participants were instructed to perform 3 times a week, alternating the chosen exercises. Their protocol was safe and feasible to apply. In the present protocol, the feedback at the end of the week was used to prepare the exercise prescription for the following week, thus preventing the individual from repeating the same exercise during the week. This was a strategy to improve the gaps of Pui Kei's protocol. However, we recognize that it is still open which model of delivery best suits the needs of the participants. Our results showed that it is essential to consider the socio-cultural conditions, the amount of family support, and personal motivations for the practice of

exercises to involve and engage participants in the practice of exercises.

CONCLUSION

We have provided information to develop a telemonitored physical exercise program based on a face-to-face physical exercise program for stroke survivors. The protocol proposes an asynchronous model of delivery for physical exercise tailored to stroke survivors' needs and that is feasible to be conducted in group sessions. This program setup needs further evaluation on exercise effectiveness, adherence, feasibility, safety, and main barriers to engage in this remote physical exercise protocol for stroke survivors.

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