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Effectiveness of a Community-based Cardiopulmonary Rehabilitation Program to the Elderly Recovered from Coronavirus Disease 2019 (COVID-19)

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Abstract

Introduction

Coronavirus Disease 2019 (COVID-19) is an infectious disease that affects patients' lung function and thus exercise tolerance. Elderly patients have shown to have more severe and long-term symptoms after contracting COVID-19. Limited evidence has been published on the effectiveness of cardiopulmonary rehabilitation programme for elderly patients recovered from COVID-19. Therefore, the aim of this study was to launch and evaluate the effectiveness of a community-based cardiopulmonary rehabilitation programme.

Methods

Participants followed a 8-week cardiopulmonary rehabilitation programme which included cardiopulmonary and strength exercises. Prior and after the rehabilitation programme, chosen parameters of lung function, physical performance and functional outcomes were recorded.

Results/ Findings

Seven participants (4 males, 3 females) with mean age of 64.7±8.6 completed the rehabilitation program. No statistical significance was found between pre- and post-rehabilitation outcome measures. However, improving trends were found across all outcome parameters. There was no statistical significance in the self-administrated questionnaires before and after the rehabilitation programme. Nevertheless, there were improving trends in all three questionnaires reporting better health and functioning, less limitations and reduced impact of breathlessness on physical and mental health.

Discussion

The study did not show any significant improvement on functional capacity, lung function or muscle strength in elderly recovered from COVID-19. However, improving trends have shown in all domains.

Implications on Physiotherapy Practice

It is to confirm that a community-based rehabilitation programme is potentially beneficial to elderly recovered from COVID-19.

Keywords: Coronavirus Disease 2019; COVID-19; community-based; cardiopulmonary rehabilitation; elderly

Introduction

Coronavirus Disease 2019 (COVID-19) is an infectious disease caused by a novel coronavirus leading to illness ranging from mild upper respiratory infections to severe pneumonia. The World Health Organization (WHO) declared the outbreak to be a Public Health Emergency of International Concern in January 2020 and recognized it as a pandemic in March 2020[1]. As of June 2022, more than 500 million cases have been reported, resulting in more than 6 million deaths across the globe [1].

Common symptoms of COVID-19 include fever, malaise, cough, and shortness of breath. Some cases were in serious condition [1]. It is recently reported that half of recovered patients in Hong Kong (HK) were still suffering from abnormal lung functions such as shortness of breath in daily activities and decreased exercise tolerance three months after being from the hospitals. Lung function of around 17 per cent of them remained poor nine months after recovery. Some patients might have a drop of about 20 to 30 percent in lung function. It is also found that significant changes were found in the functional respiratory capacity (FRV) and diffusion capacity of elderly patients diagnosed with COVID-19 for up to 6 months [23, 24].

Besides the impacts on physical and physiological functions, about 19 percent of the recovered COVID-19 patients expressed that they suffered depressive symptoms while 12 percent of them experienced anxiety. Medical doctors encouraged the recovered COVID-19 patients to participate in physiotherapy and perform regular exercise to strengthen their lungs [2, 3].

Current data showed that most people contracted COVID-19 recovered but the long-term effects of the illness such as declined bodily functions are not fully understood, particularly for patients who need more intensive care and the elderly. It is most likely that these ongoing complications will disproportionately affect the elderly especially in those with acute or chronic health conditions [4, 5].

Since the 5th wave of the pandemic, local figures revealed that the number of COVID-19 patients aged equal to or above 60 years old has reached over 300,000 [6]. On the other hand, a systematic review showed that the percentage of older adults meeting recommended physical activity ranged from 2.4 – 83.0% across the studies [22].

In view of the large number of older adults recovered from COVID-19 living in the community and varied physical activity level among them, a community based physical and cardiopulmonary rehabilitation programme should be rolled out and the effectiveness of the program should be investigated. It is hypothesized that the community based physical and cardiopulmonary rehabilitation programme is effective for older adults recovered from COVID-19 living in the community.

Methods

Subject Recruitment and Ethical Approval

The study was conducted in a district non-governmental organization. Elderly recovered from COVID-19 fulfilling the inclusion and not the exclusion criteria were recruited to the study. Before the commencement of the study, ethical approval was sought from the Research and Ethics Committee of XXX (approval reference number HRE210125).

Inclusion and Exclusion Criteria

Participants were recruited if they fulfilled the following inclusion criteria: (1) recovered from COVID-19; (2) able to walk independently with or without walking aids; (3) does not undergo major operations in the past 3 months; and (5) able to obey and follow instructions. Participants were excluded if they did not fulfil the inclusion criteria, not cooperative or have unstable medical conditions or musculoskeletal diseases which affect mobility.

Study Design

Participants performed a structured 8-week community based cardiopulmonary rehabilitation programme after recruitment. Duration of the whole training programme was 8 weeks. The workflow of the program is shown in Figure 1.

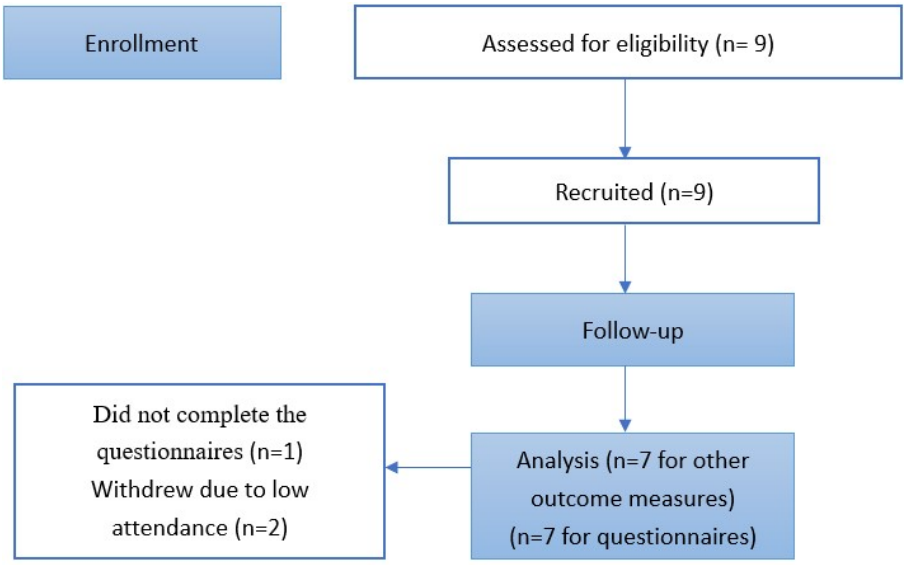

Figure 1: CONSORT Flow diagram

After recruitment, the participants were given a consultation session for baseline assessment and an educational talk about the importance of staying physically active during and after the pandemic. The participants were required to attend a face to face 1-hour exercise class once a week for a total of 8 weeks. The participants were also given a water dumbbell home cardiopulmonary exercise video, a pedometer watch and a resistance exercise band for continuing different types of exercise at home. They were strongly encouraged to perform all the provided exercise for 5-7 days per week. A logbook was given to record participants' number of steps and the frequency of performing exercises every day. It was to self-empower the participants to develop the habit of exercise.

Outcome Measures

Prior to the training, participant characteristics e.g., gender, age, time post COVID-19, past medical history, functional status etc., were collected from the participants. The following outcome measures on the aspects of lung function, physical performance and

functional outcomes were chosen and recorded:

1. Forced expiratory volume in one second (FEV1) and forced vital capacity (FVC): these are usually measured during a pulmonary function test.

2. Short Physical Performance Battery (SPPB): it is a test of lower extremity functioning which combines scores from usual gait speed, timed tests of balance and chair stands of the participants. Scores range from 0-12 with higher score indicating better functioning.

3. 6-min Walk Test (6MWT): it is widely used as an indicator of cardiorespiratory endurance and can be accessed as the most distance an individual can walk in 6 minutes.

4. Isometric deltoid and gluteal muscle strength: these muscle strengths were used to measure proximal muscle strengths of the participants.

5. Handgrip strength: it was used to measure distal muscle strength of the participants.

6. Chinese version of Saint George's Respiratory Questionnaire (SGRQ): the SGRQ is a specific tool to measure the impact of overall health and perceived well-being in patients with impaired lung functions. It consists of 50 items that assess patients in three domains (symptoms, activity and impacts). The total scores range from 0 to 100 with higher scores indicating more limitations.

7. Chinese Version of 36-Item Short Form Health Survey (SF-36): it is a 36-item self-report measure of health-related quality of life (HRQOL). There are eight subscales measuring different domains of HRQOL: physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional (RE), and mental health (MH). Two component scores are derived from the eight subscales: a physical health component score and a mental health component score. The higher the scores, the better are the health and functioning.

8. Chinese version of Dyspnea-12 (D-12): it is a convenient patient-reported scale that assesses the severity of breathlessness through specific verbal descriptors. This self-administered questionnaire consists of 12 items focusing on the impacts of breathlessness in both the physical and emotional aspects of patients with cardiopulmonary diseases.

Statistical Analysis

Statistical analysis was conducted using the Statistical Package for Social Sciences for Windows (SPSS). Descriptive data with normal distribution was presented as mean ± standard deviation (SD). Independent t-tests for parametric data and Mann-Whitney tests for non-parametric data were conducted to identify any difference between the pre- and post-rehabilitation programme. A significance level of $p<0.05$ was used for all comparisons.

Results/ Findings

Nine participants were enrolled to the study. Seven participants (4 males, 3 females) with mean age of 64.7±8.6 completed the rehabilitation program. Two participants were excluded due to low attendance. All participants who completed the program are non-smokers. The outcome measures are shown in Table 1.

Outcome measures (mean)	Pre (n=7)	Post (n=7)
6MWT (m)	324.86±80.23	385.43±113.64
SPPB	10.29±1.7	11.57±0.53
FEV1/FVC (%)	75.2±3.55	78.6±4.47
FEV1 (%Pred)	115.43±25.38	117.43±19.38
Handgrip (kg)		
Left	27.79±10.58	29.48±11.17
Right	30.31±11.76	30.55±11.43
Deltoid (MMT score)		
Left	4.43±0.73	4.86±0.38
Right	4.64±0.63	5±0
Gluteal (MMT score)		
Left	4.36±1.11	4.64±0.94
Right	4.5±0.76	4.86±0.38

MMT= manual muscle testing; p>0.05 in all outcome measures

Table 1: Results of the outcomes

No statistical significance was found between pre- and post-rehabilitation outcome measures. However, improving trends were found across all outcome parameters. 6MWT distance and SPPB were found to have greater improvements than the other parameters after the rehabilitation programme, with a 19% and 12% increase respectively. The right handgrip strength had the least improvement, with only 0.8% increase post rehabilitation.

One participant did not complete the questionnaires therefore only six sets of questionnaires were analysed. There was no statistical significance in the self-administrated questionnaires before and after the rehabilitation programme. Nevertheless, there were improving trends in all three questionnaires. With an increasing score in SF-36 and reduction in SQRQ and Dyspnea-12 scores, participants reported better health and functioning, less limitations and reduced impact of breathlessness on physical and mental health.

Discussion

There is limited available scientific evidence in the literature regarding the effectiveness of a community-based cardiopulmonary in elderly patients recovered from COVID-19. This study aimed to design a rehabilitation programme to improve cardiopulmonary functions for this group of patients.

The rehabilitation programme consisted of aerobic exercises such as upper limb and lower limb ergometer as well as at-home strengthening exercise with resistance exercise bands. Although the results of the outcomes were not statistically significant, there

were improving trends across all outcome measures. The lack of statistical significance of the outcome measures may be due to an insufficient sample size. The large variation in 6MWD may have contributed to the insignificant result. Even the results were not statistically significant, an improvement of 60m in 6MWT and an increase of more than 1 point in SPBB can be considered as clinically meaningful [7].

The average 6MWT distance (6MWD) increased in post-rehabilitation. This is in line with other studies that investigated the effectiveness of in-patient rehabilitation programme post COVID-19. Previous literatures have shown that 6MWD increased significantly after rehabilitation [8,9]. Longer 6MWD indicates better functional capacity [10]. Aerobic training, cycle ergometer, has found to improve cardiorespiratory fitness, endurance parameters and muscle strength in elderly [11]. Another study on healthy elderly also showed that both upper limb and lower limb ergometer improved submaximal and maximal exercise capacity [12]. Increased aerobic fitness and muscular strength lead to a higher exercise capacity and thus a longer 6MWD.

In terms of lung function, the study did not produce any significant result in FEV1/FVC or FEV1. However, there was an increasing trend when comparing the pre- and post-rehabilitation programme. This is observed in other studies which investigated the effect of physical activity on lung function in elderly. Dogra et al reported that more physical activity were associated with better lung function [13]. She and her team has also found that replacing sitting with physical activity improved lung function in elderly with and without lung disease 14. Increasing level of physical activity seems to have a positive correlation with lung function.

Although insignificant, muscular strength was slightly better post-rehabilitation. There was an increase in handgrip strength and better average manual muscle testing score on both deltoid and gluteal muscles. Resistance training has found to be beneficial in increasing muscle mass, muscle strength as well as functional performance such as balance and strength level in older adults [15-17]. With increased muscle strength, walking speed also increased 18. Walking has found to contribute the most in older adults' daily physical activity [19]. With the well-established relationship between muscle strength and functional performance, resistance training should be incorporated in the rehabilitation programme.

There were improving trends in all three self-administered questionnaires. With an increasing score in SF-36 and reduction in SQRQ and Dyspnea-12 scores which indicate better health and functioning, less limitations and reduced impact of breathlessness on physical and mental health in the participants. The findings concerning SF-36 and SQRQ were found consistent to other studies on impact of pulmonary rehabilitation programme for patients with chronic lung diseases [20,21]. There is limited evidence on the use of Dyspnea-12 as outcome measures in running structured exercise programme on patients or on elderly.

There are several limitations in this study. The most important one is the small sample size. It was primarily due to the difficulty in participant recruitment. As the study was conducted during the COVID-19 pandemic, many potential participants declined to participate as they worried about being re-contracted in non-home environment. The small sample size may have led to an insignificant result and increased the likelihood of type II error. Moreover, the self-reported nature of the water dumbbell exercise and resistance band exercises may have further skewed the result. The result relied on honest and accurate report from participants. Due to these limitations and the insignificant results produced, it is therefore unclear that if the rehabilitation programme is effective or not. Therefore, future studies with larger sample size are needed to verify the effectiveness of a rehabilitation programme for post-COVID-19 elderly patients.

Implications of Physiotherapy Practice

Most people contracted COVID-19 recovered but the long-term effects of the illness such as declined bodily functions are impacting on those requiring more intensive care and the elderly. In view of the large number of older adults recovered from COVID-19 living in the community, a community based physical and cardiopulmonary rehabilitation programme should be rolled out and the effectiveness of the program should be investigated.

Whilst the current study did not show any significant improvement on functional capacity, lung function or muscle strength in elderly recovered from COVID-19, improving trends have shown in all domains. It is to confirm that a community-based rehabilitation programme is potentially beneficial to elderly recovered from COVID-19.

Questionnaire	Pre (n=6)	Post (n=6)
SF-36		
Physical functioning	79.17±19.88	81.67±16.24
Role limitations due to physical health	79.17±19.88	81.67±16.24
Role limitations due to emotional problems	83.33±25.46	72.22±40.45
Energy/fatigue	59.17±20.5	58.33±12.47
Emotional well-being	74.67±10.24	77.33±12.15
Social functioning	81.25±26.76	85.42±15.17
Pain	72.5±21.70	85±10.21
General Health	63.33±27.49	64.17±23.17
SQRQ	24.91±19.51	21.4±18.63
Dyspnea-12	3.33±6.21	2.5±4.39

SF-36= Chinese Version of 36-Item Short Form Health Survey; SQRQ= Chinese version of Saint George's Respiratory Questionnaire; Dyspnea-12= Chinese version of Dyspnea-12; p>0.05 in all scores

Table 2: Result of questionnaires' scores

Data Availability Statement

Data collected are available on request.

Funding Statements

The research leading to these results has received funding from the Rotary Club of City Northwest Hong Kong.

Conflict of Interest Disclosure

Tiffany Ching Man Choi, Kenneth Au Yeung and George Kwok Cheong Wong declare that they have no conflict of interest.

Ethics Approval Statement

Sought from the Research and Ethics Committee of Caritas Institute of Higher Education (approval reference number HREXXXXXX).

Patient Consent Statement

Written consent forms were collected from all subjects.

Permission to Reproduce Material from Other Sources

Not applicable

Study Registration

Not applicable

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