The Effect of the Physical Fitness and Breathing Training Program in COVID-19 patients in Wuhan, China: prospective study

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Keywords: COVID-19, Pulmonary rehabilitation, Symptom

Posted Date: October 21st, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-92706/v1>

Abstract

Background Corona Virus Disease 2019 (COVID-19) has adverse effects on patients' respiratory system. Therefore the pulmonary rehabilitation is particularly necessary for COVID-19 patients. A recent qualitative study indicated that patients perceived the impact of fatigue on their daily lives to be a key factor in decreasing their quality of life. This study aimed to investigate the knowledge and needs of physical fitness and breathing training, and to explore the impact of physical fitness and breathing training on COVID-19 patients.

Methods From Feb 16, 2020 to Apr 6, 2020, a self-designed questionnaire was used to investigate the knowledge and needs of physical fitness and breathing training in COVID-19 inpatients. And then the participants received an intervention about physical fitness and breathing training which lasted 2 weeks. The 9-item Functional Assessment of Chronic Illness Therapy-Fatigue scale (FACIT-F) was used to measure COVID-19 related fatigue before and after the intervention.

Findings According to a 5-point Likert scale, the 133 COVID-19 patients had only an "not really" and "uncertain" knowledge of physical fitness and breathing training (2.47 ± 1.17). 86.98% of the patients expected to receive guidance of physical fitness and breathing training through video teaching. Differences were observed in fatigue, General fatigue component (15.0(8.0) vs. 19.0(10.0), $P < 0.01$); Functional ability component (4.0 (3.0) vs. 7.0(4.0), $P < 0.01$); Psychological component (6.0(5.0) vs. 7.0 (5.0), $P < 0.01$), after the intervention, Moderate degree (36.09% vs. 28.57%) alleviated to mild degree (51.12% vs. 66.91%). SpO₂-% 86 ((75, 89) vs. 92(89, 98), $P < 0.001$), and Oxygen flow-L/min (2(0,4) vs. 8(3,9), $P < 0.001$). In our study, 130 healthcare professionals took part in this program. None of the participants reported covid-19 related symptoms. When the participants returned home, they all tested negative for SARSCoV- 2 specific nucleic acids and IgM or IgG antibodies (95% confidence interval 0.0 to 0.7%).

Interpretation COVID-19 patients had insufficient knowledge of physical fitness and breathing training for pulmonary rehabilitation. Patients should be guided to receive training, which can be benefit for patients.

Introduction

Corona Virus disease 2019 (COVID-19) is a severe acute respiratory disease caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2)^[1]. The population is generally susceptible because the transmission route of COVID-19 is mainly spread by respiratory droplets ^[2], and the epidemic quickly spreads to the whole world. At March 12th, World Health Organization (WHO) characterized it as a global pandemic ^[3].

COVID-19 has adverse effects on patients' respiratory system, physical function and psychological function, therefore the pulmonary rehabilitation is particularly necessary for COVID-19 convalescent patients. It may be of value for all patients in whom respiratory symptoms are associated with

diminished functional capacity or reduced health-related quality of life (HRQL)^[4]. Furthermore, emerging evidence supports the use and benefits of the program in other chronic respiratory diseases, such as idiopathic pulmonary fibrosis, interstitial lung disease, and others. The previous studies have shown that pulmonary rehabilitation can stabilize or improve the functional status of patients^[5, 6].

The National Health Commission of the People Republic of China (NHC) has published the General Office of the National Health Commission on printing and distributing rehabilitation plans for discharged patients with COVID-19 (Trial)^[7]. The document emphasized the importance of COVID-19 patients for pulmonary rehabilitation, which hospital medical personnel should pay attention to it to improve patient's dyspnea and dysfunction, reduce the complications, recovery the greatest possible ability of daily life activities.

Fatigue is identified as the most commonly detected. It is demonstrated that fatigue played a strongly negative effect on COPD patients. COPD-related fatigue is acknowledged to associate with COPD patients' worse health status^[8–10], and also exerts a negative impact on daily lives, physical functioning and emotional well-being^[9, 11, 12].

This study aimed to investigate the knowledge and needs of physical fitness and breathing training, and to explore the impact of physical fitness and breathing training on COVID-19 patients.

Materials And Methods

Objectives

This was a prospective study. The present study aimed to investigate the knowledge and needs of physical fitness and breathing training, and to explore the impact of physical fitness and breathing training on fatigue in COVID-19 patients.

Participants

The inclusion criteria were as follows: (1) Age older than 18 years; (2) Informed consent form was signed; (3) Patients was diagnosed of COVID-19. The exclusion criteria were as follows: (1) Patients with psychotic disorder or dementia; (2) Patients didn't have smart phones. The data for demographic information and clinical data were collected.

Assessment of knowledge and needs for physical fitness and breathing training

The self-designed questionnaire, including the general condition of patients, the knowledge of physical fitness and breathing training, the frequency of actual physical fitness and breathing training and the needs for teaching methods. The physical fitness and breathing training knowledge and needs scale referred to the General Office of the National Health Commission on printing and distributing rehabilitation plans for discharged patients with COVID-19 (Trial)^[7] and recommendations for respiratory

rehabilitation of COVID-19 in adult^[13]. There were 5 kinds of pulmonary rehabilitation programs, included breathing training apparatus, abdominal breathing, pursed-lip breathing, breathing rehabilitation physical fitness, aerobic physical fitness and strength training. The scale included four aspects: whether the patients know the relevant knowledge of pulmonary rehabilitation, whether they have mastered the training methods of pulmonary rehabilitation, the training frequency of patients who have mastered pulmonary rehabilitation, and the expected teaching ways. Patients' understanding are according to a 5-point Likert scale were assigned according to "very much", "relatively", "uncertain", "not really" and "not at all". The higher score, the better the patients' understanding. Through the "mastered" and "not mastered" options we can understand whether the patient can carry out pulmonary rehabilitation training independently.

Assessment of Chronic Illness Therapy-Fatigue scale

The 9-item Functional Assessment of Chronic Illness Therapy-Fatigue scale (FACIT-F) was demonstrated to be reliable and valid for measuring COPD-related fatigue^[14, 15]. The 9-item FACIT-F scale consists of three components: general fatigue (5 items), functional ability (2 items) and psychological fatigue (2 items). Each item is rated from 0 to 4 and the overall score ranges from 0 to 36, with a higher score signifying less fatigue^[16]. We applied the cut-off of 12 and 24 points, thus patients' fatigue degree was classified as mild (FACIT-F score 24 to 36), moderate (12 to 23) and severe (0 to 11). The Cronbach's alpha of the 9-item FACIT-F scale was 0.89 in this study.

Intervention

The Physical fitness and Breathing Training Program (appendix 1) for COVID-19

The training content was presented using instructional video materials teaching and face-to-face interactive reminder. The instructional video materials were conducted by Wechat in personal mobile phone. This was a 2 weeks program.

Statistical analyses

The patient's characteristics were presented as mean $\pm$ SD for continuous variables, and showed as interquartile range (IQR) for non-normally distributed continuous variables. Categorical variables were showed as percentages. For categorical variables, Chi-square test was used. Mann-Whitney U test was applied to compare if there were any significant differences in the mean scores between the two groups. All calculation was performed with SPSS 22.0. A P value of less than 0.05 was considered to be significant.

Results

Totally 133 COVID-19 patients were investigated. Among these participants, 74 (55.64%) female, 50.38% were 50 ~ 64 years old. The patient diagnosed of Diabetes was 13 (9.77%), Hypertension 26 (19.55%),

Cardiovascular diseases 16 (12.03%), and Cancer 5(2.76%) (shown in Table 1).

The knowledge of pulmonary rehabilitation

The patients who knew the breathing training apparatus was the least (19%14.29%), and those who knew the aerobic physical fitness accounted for 64%48.12%, which was better than other items. Measured on a 5-point Likert scale, the total understanding degree of physical fitness and breathing training (2.47 ± 1.17) had only "not really" and "uncertain". In terms of the understanding degree of aerobic physical fitness (3.05 ± 1.09) is between "uncertainty" and "relatively", the understanding degree of pursed-lip breathing (2.23 ± 1.11), abdominal breathing (2.72 ± 1.23), breath rehabilitation physical fitness (2.36 ± 1.11), and strength training (2.41 ± 1.12) is between "not really" and "uncertain". Breathing training apparatus (1.93 ± 0.25) is between "not at all" and "not really" (shown in Table 2). The patients whether mastered the methods of physical fitness and breathing training, the result displayed that only 9%6.77% of the patients mastered how to use the breathing training apparatus. By contrast, most patients knew how to do aerobic physical fitness (72%54.14%). In addition, mastering abdominal breathing accounted for 54%40.60%, pursed-lip breathing accounted for 30%22.56%, respiratory rehabilitation physical fitness s accounted for 38%28.57%, and strength training accounted for 33%24.81%(shown in Table 3).

The needs for physical fitness and breathing training methods

Among the patients, 18%13.44% expected face to face teaching, 11%86.98% expected video teaching, 47%35.43% expected graphics and text teaching.

Comparison before and after the Physical fitness and Breathing Training intervention

The present study demonstrated that 68%51.12%, 48%36.09% and 17%12.79% of COVID-19 patients experienced mild, moderate and severe fatigue, respectively. The significant differences were observed in fatigue, General fatigue component (15.0(8.0) vs. 19.0(10.0), $P < 0.01$); Functional ability component (4.0(3.0) vs. 7.0(4.0), $P < 0.01$); Psychological component (6.0(5.0) vs. 7.0(5.0), $P < 0.01$), after the intervention, Moderate degree (36.09% vs. 28.57%) alleviated to mild degree (51.12% vs. 66.91%), SpO₂-% 86 ((75, 89) vs. 92(89, 98), $P < 0.001$), and Oxygen flow-L/min (2(0,4) vs. 8(3,9), $P < 0.001$) (shown in Table 4).

The healthcare professionals and exposure

There were 130 healthcare professionals took part in this program. None of them reported covid-19 related symptoms during the deployment period in Wuhan. When they returned home, none of the nasopharyngeal swabs collected from them tested positive for nucleic acids on the reverse transcriptase polymerase chain reaction assay for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). None of the serum samples of healthcare professionals tested positive for SARS-CoV-2 specific IgM or IgG antibodies (95% confidence interval 0.0 to 0.7%)^[17].

Discussion

Our investigation used the self-designed questionnaire to determine the knowledge and needs of patients with COVID-19 in physical fitness and breathing training for pulmonary rehabilitation. The finding from this study indicated that patients generally had a low level of knowledge of physical fitness and breathing training, such as breathing training apparatus, pursed-lip breathing, and breath rehabilitation physical fitness. The reason may be the patients have few respiratory basic diseases, and during the outbreak period, rehabilitation medical personnel do not recommend to carry out physical therapy and rehabilitation training in the ward of patients with COVID - 19 lest they get infected^[18]. In this study, the training content was presented using instructional video materials teaching combined with face-to-face interactive reminder. It should be benefit for the patients to improve their knowledge level.

The prevalence of moderate to severe fatigue was 48.88% in COVID-19 patients, which was consistence with the COPD patients admitted to hospitals with an acute exacerbation, which is a more severe group of patients ^[15].

The American Thoracic Society (ATS) and the European Respiratory Society (ERS) pointed out that physical fitness and breathing training was the cornerstone of pulmonary rehabilitation. The core of pulmonary rehabilitation is physical fitness training, patients should gradually transfer from the early respiratory muscle training to the whole body physical fitness training, aerobic physical fitness, and then according to the rehabilitation assessment to the strength training, finally to the appropriate form of physical fitness and intensity training^[4, 19]. Physical fitness training program had identified it improved both the cardiorespiratory and musculoskeletal fitness in patients recovering from SARS^[20].

In this study, the training program which gradually transferred from the early respiratory muscle training to the whole body physical fitness training, aerobic physical fitness , and according to the rehabilitation assessment, finally to the appropriate form of physical fitness and intensity training. The significant differences were observed in fatigue, SpO2 and oxygen flow after the intervention, moderate degree alleviated to mild degree. According to recommendations for respiratory rehabilitation of COVID-19 in adult^[13], patients should have aerobic physical fitness for 3~5 times a week, 20~30min each time, strength training for 2~3 times a week, training for 6 weeks, abdominal breathing, pursed-lip breathing, breathing rehabilitation physical fitness s for 2 times a day, 15~45min each time. However, most of the patients in the survey practice breathing training apparatus, abdominal breathing, respiratory rehabilitation physical fitness s and aerobic physical fitness for 2 weeks, which were less than the recommended physical fitness time for the participants discharged.

Most of the patients expect to be taught by video. Video and picture text teaching can simultaneously guide multiple groups and it is convenient, it also can reduce the people contact in special periods. Not only saves medical resources, reduces the workload of medical staff, but benefits a wide range of people.

Besides sports training, it also includes the comprehensive measure such as the psychological intervention and health education. Therefore, professional clinicians, clinical nurses, rehabilitation physicians and psychological therapists should make promotional videos or graphics which related to

pulmonary rehabilitation together. In terms of increasing the completion degree of patients' pulmonary rehabilitation training, patients' compliance can be improved through WeChat group punch, family member supervision, online mutual supervision between patients and online supervision of medical staff. Some scholars guided respiratory rehabilitation can be conducted by providing video and remote telephone guidance to COVID-19 patients ^[21].

In our study, all healthcare workers were responsible for Physical Fitness and Breathing Training Program, which included face to face training procedures on a routine basis. We implemented a more stringent protocol for our participants as a necessary precaution, which included wearing N95 respirators and surgical masks at the same time. In addition, they were well trained in hand hygiene, putting on and taking off personal protective equipment. During training procedures, healthcare workers were equipped with standards personal protective equipment, including protective suits, masks, gloves, goggles, face shields, and gowns^[17] (shown in table5).

Several potential limitations should be mentioned regarding the present study. First, participants were recruited convenience sampling only from the inpatient department.

So the generalization of the findings might be limited. Future research among patients from different settings (eg, inpatient, outpatient, community) and with different status is advised. Second, this study adopted fatigue rather than details of FEV1 to measure benefit of training program, the correlation between fatigue score and COVID-19 severity may be weak.

Conclusions

This study investigated the knowledge and needs of COVID-19 convalescent patients for pulmonary rehabilitation. Most patients have insufficient knowledge of pulmonary rehabilitation and hope to be guided by video teaching. We should not only pay attention to guide the knowledge and operation of pulmonary rehabilitation for COVID – 19 convalescent patients, but supervise in many ways in order to enhance the patient's compliance.

Declarations

Ethical Approval and Consent to participate

The study protocol was approved by the Ethics Committee of XXX Hospital, XXX University. The COVID-19 patients were recruited between Feb 16, 2020 and Apr 6, 2020. In the form of online survey, questionnaires were sent to the study population through WeChat group to complete. Each WeChat ID can only be answered once to avoid duplication of information collected. All respondents provided informed consent.

Consent for publication

All authors agreed to submit and publish.

Availability of supporting dataNot applicable.

Competing interests

All authors have completed the ICMJE uniform disclosure form. The authors have no conflicts of interest to declare.

Funding

No source of funding.

Authors' contributions

Shouzhen Cheng and Qingtang Zhu designed the study. Jianying Li, Zhiying Li, Ying Zheng, Tianwen Huang, Ming Zhao, Jinfang Qiao and ZhiHao Chen acquired, analysed, or interpreted the data. Lu Lu and Meng Yu Qi did the statistical analysis or literature searching. Jianying Li wrote this article.

Acknowledgments

We gratefully acknowledge all health care professional on the front line of West Hospital of Union Hospital, Tong ji Medical College, Hua zhong University of Science and Technology and The First Affiliated Hospital of Sun Yat-sen University and all the patients involved in the study

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Tables

Table 1 Participant characteristics at baseline			
Variable		n	%
Gender			
Male		59	44.36
Female		74	55.64
Education			
Primary or below		23	17.29
high school		57	42.86
college or above		53	39.85
Age			
15~49		53	39.85
50~64		67	50.38
≥65		13	9.77
Marital status			
Unmarried		15	11.28
Married		118	88.72
Occupation			
Employed		74	55.63
Retired & Unemployed		59	44.37
BMI (kg/m ²)			
Underweight (BMI < 18.5)		10	7.61
Normal weight (18.5 ≤ BMI < 24.0)		90	67.69
Overweight (24.0 ≤ BMI < 28.0)		24	18.13
Obesity (BMI ≥ 28.0)		9	6.57

Table 2. The understanding degree of pulmonary rehabilitation.							
	Not at all		Uncertain		Very Much		
	N	%	N	%	N	%	
Breathing training apparatus	105	78.95	9	6.77	19	14.29	1.93±0.25
Abdominal breathing	70	52.63	18	13.53	45	33.84	2.72±1.23
Pursed-lip breathing	96	72.18	11	8.27	26	19.55	2.23±1.11
Respiratory exercis	87	65.42	18	13.53	28	21.06	2.36±1.11
Aerobic physical fitness	54	40.61	15	11.28	64	48.12	3.05±1.09
Strength training	84	63.15	19	14.29	30	22.56	2.41±1.12
Note: very much includes "very much" and "relatively", not at all includes "not really" and "not at all".							

Table 3 Knowledge of the training methods of pulmonary rehabilitation					
Program	Master		Not master		
	N	%	N	%	
Breathing training apparatus	9	6.77	124	93.23	
Abdominal breathing	54	40.60	79	59.40	
Pursed-lip breathing	30	22.56	103	77.44	
Respiratory rehabilitation physical fitness	38	28.57	95	71.43	
Aerobic physical fitness	72	54.14	61	45.86	
Strength training	33	24.81	100	75.19	

Table 4 Comparison of FACIT-F and vital signs before and after intervention in COVID-2019 patients (n=133)

Variables	Before	After	U
FACIT-F	Md (IQR)	Md(IQR)	
Total score	26.0(17.0)	31.0(20.0)	-4.023**
General fatigue component	15.0(8.0)	19.0(10.0)	-4.145**
Functional ability component	4.0 (3.0)	7.0(4.0)	-4.098**
Psychosocial component	6.0(5.0)	7.0(5.0)	-3.985**
Fatigue degree	n(%)	n(%)	χ^2
Mild	68(51.12)	89(66.91)	19.073**
Moderate	48(36.09)	38(28.57)	9.347*
Severe	8(12.79)	6(4.52)	2.965
	Md(25 th ,75 th)	Md(25 th ,75 th)	<i>P</i>
SpO2-%	86(75,89)	92(89,98)	<0.001**
Oxygen flow-L/min	2(0,4)	8(3,9)	<0.001**
Temperature-°C	37.0(36.5,38.1)	36.8(36.4,37.8)	0.782
SBP-mmHg	134.5(123,148)	131(136,140)0.	0.802
DBP-mmHg	75(65,82)	76(67.83)	0.663
Pulse-beats/min	85(80,94)	86(78,92)	0.758

Note:**P<0.01; *P<0.05

Table 5 | Personal protective equipment provided to study participants for prevention of covid-19

Personal protective equipment	Ward*			AGP+ exposure
	Intensive care units	Regular wards	No covid-19 contact area	AGPs
Mask:				
N95 respirator	+	+	-	+
Surgical mask	+	+	+	+
Medical suit	+	+	-	+
Isolation gown	+	+	-	+
Apron	-	-	-	+
Gloves	+	+	-	+
Eye protection	+	+	-	+
Hair cover	+	+	-	+
AGP=aerosol generating procedure; covid- 19=coronavirus disease 2019. *Overlap existed between the different wards. +Powered air purifying respirator used when performing tracheal intubation.				

Figures

Figure 1

Patient flow in this study. FACIT-F : Cronic Illness therapy-Fatigue scale.

Supplementary Files

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