

The effect of pulmonary rehabilitation on covid-19 patients

FM Alahmri^{1*}, SB Muaitheer¹, HS Alsharhan¹, SS Alotaibi¹, HJ Alotaibi² and SM Alsaadi³

¹Department of Medical Rehabilitation, Ministry of Health, Riyadh, Saudi Arabia

²Department of Clinical Laboratory, King Abdulaziz Medical City, Riyadh, Saudi Arabia

³Department of Physical Therapy, College of Applied Medical Sciences, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Abstract

Background: The global pandemic COVID-19 is a highly infectious disease that affects the respiratory system. The novel coronavirus also is known as severe acute respiratory syndrome (SARS)-CoV-2. The pulmonary rehabilitation has been effectively used in pneumonia patients and it may play a big role in increasing the efficacy of the lung and the oxygen saturation in the blood of COVID-19 patients.

Objectives: The purpose of the study is to investigate the short effect of pulmonary rehabilitation on the lung inspiratory volume, oxygen saturation in the blood, and heart rate in COVID-19 patients.

Methods: Thirty COVID-19 patients were enrolled in the study, with mild to moderate symptoms. Each participant underwent a breathing exercises program. The measurements include lung inspiratory volume, oxygen saturation in the blood, and heart rate before and after the exercises.

Results: IBM SPSS software used for statistical analysis. The paired t-test was used to compare the means pre- and post-the breathing exercises with p-value>0.05. The results showed a significant difference in inspiratory lung volume and SPO₂ 0.001.

Conclusion: The pursed lip breathing exercise showed to be efficient in increasing inspiratory lung volume and spo₂.

Introduction

The novel coronavirus outbreak causing a global pandemic is highly infectious disease, by Person-to-person transmission, mainly transmitted through respiratory droplets and close contact [1]. Also known as severe acute respiratory syndrome (SARS)-CoV-2. The covid-19 mainly affects the respiratory system. It has been shown that the disease affects other systems which may lead to death in severe cases, due to diminished physical and pulmonary functions [1].

Pulmonary rehabilitation is a conservative treatment that includes several programs such as exercises, health education, and breathing techniques for patients who have lung conditions. It has been used in several studies and it showed to be effective in decreasing the symptoms and increase the efficacy of the lungs [2].

The respiratory rehabilitation might be helpful to lighten the burden on the respiratory ventilators. Therefore, in the current study will investigate the effect of respiratory rehabilitation on COVID-19 patients.

Pulmonary rehabilitation is a program designed to enhance lung efficacy and lung function by increasing lung volume. The normal lung volume of an adult human male is about 6 litres of air [3]. The lung volume can be measured by Tidal volume (TV), Expiratory reserve volume (ERV), Residual volume (RV), and Inspiratory reserve volume (IRV). It can be measured by a spirometer.

Residual volume (RV) is a lung volume indicated for the amount of air left in the lungs after a forced exhalation; this volume cannot be measured, only calculated. The lung capacities that can be calculated include vital capacity (ERV+TV+IRV), inspiratory capacity (TV+IRV), functional residual capacity (ERV+RV), and total lung capacity (RV+ERV+TV+IRV) [3].

Pulmonary rehabilitation has been shown to be effective in managing symptoms of different lung problems and helped to increase the efficacy of the lungs [2]. A systematic review by Santino et al. found that breathing exercises for adults with asthma was improve the quality of life and decrease their symptoms [4]. Bakry et al. studied the Pulmonary rehabilitation in chronic obstructive pulmonary disease (COPD) their result showed that short-term pulmonary rehabilitation program improves the lung volume and function. These findings showed that even if the program duration is short-term, it can help in recovering for patients with COPD [5]. Weiliang et al. conducted a randomized controlled trial to assess the effects of daily breathing pattern changes on stable patients with COPD and that's led to improving degree of dyspnoea, and exercise capacity [6].

Another study investigated the effect of inspiratory muscle training on exercise performance and quality of life in patients with chronic obstructive pulmonary disease. Their result showed that pulmonary exercises led to a significant improvement in lung function and improved dyspnea [7]. In addition, Susi Kriemler et al. studied the short-term effect of the exercises on the sputum expectoration the result significantly showed improvement after exercises and increase in oxygen saturation was significantly higher after the exercises. However, there were no effects observed on lung function [8].

*Correspondence to: FM Alahmri, Department of Medical Rehabilitation, Ministry of Health, Riyadh, Saudi Arabia, E-mail: alahmri999@gmail.com

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Systematic review by Lu-Lu Yang et al. investigated pulmonary rehabilitation for patients who recovered from COVID-19 and having complications, such as chronic pulmonary disease. They found that pulmonary rehabilitation showed improvement of the patients symptoms. concluded that pulmonary rehabilitation is necessary post recovery [9].

Pursed-lip Breathing exercise is an effective method to increase lung function and respiratory muscle strength. And that was studied by Sarawut Jansang et al. they measure the ratio vital capacity, expiratory volume in one second, and maximal inspiratory pressure. Their result showed significantly increase in lung capacity [10]. Furthermore, a study showed that slow loaded breathing exercises can improve blood pressure, Lung Capacity and Exercise Endurance by increases inspiratory muscle strength [11].

On the other hand, Jiang et al. claimed that pulmonary rehabilitation is less clinical therapy for severe COVID-19 patients and low efficient [12]. Therefore, the primary aim of the present study was to investigate the effect of pulmonary rehabilitation in COVID-19 patients. Respiratory rehabilitation might be helpful in managing COVID-19 respiratory symptoms. And to lighten the burden on the respiratory ventilators.

Materials and methods

Ethical standards and study design

The presented experimental study was approved by the Institutional Review Board (IRB) of Health Ministry, Riyadh, Saudi Arabia (IRB- log no: 20-125M), Participants were recruited from King Khaled hospital in Al-Kharj city, Riyadh district, Saudi Arabia. which was designated by the ministry of health to admit COVID-19 patients.

The inclusion criteria were patient with positive diagnosis of COVID-19 with respiratory symptoms; aged 20 years to 55 years; and no COPD or any other respiratory disease, and the Exclusion criteria were patient with respiratory, cardiac and/or neurological pathology, sever cases and symptoms, and patients unable to take deep breath effectively due to pain or diaphragmatic dysfunction.

The sample size was calculated by power analysis based on a study conducted by Jansang et al. [10] using the values of shortening of breath pre- and post-pursed lip breathing exercise. The mean of shortening of breath pre-exercise (μ_0 value) was 8.35 scores, the mean score of shortening of breath post the exercise (μ_1 value) was 7.64 scores, and the standard deviation (σ) was 0.90. The power analysis was based on a two- tailed test, an alpha level of .05 and a power of .80. A sample size of 13 participants was required for the study. However, we will increase the sample size to 30 participants in order to increase the accuracy.

The sample size analysis was conducted using the web page of the Department of Statistics at the University of British Columbia: <https://www.stat.ubc.ca/~rollin/stats/ssize/n1a.html>.

Instruments

Incentive spirometer: (Airlife™, Carefusion, Yorba Linda, CA, USA) (Figure 1).

An incentive spirometer is a device that measures how deeply a person can inhale. It helps to take slow, deep breaths to expand and fill the lungs with air. To measure the lung volume. Tidal volume and inspiratory reserve volume. It has been studied and showed to be valid and reliable [13].

Pulse oximeter: (Pulsox-7; Minolta Company Ltd, Milton Keynes, UK) (Figure 2).

The device is a small, lightweight used to measure the amount of oxygen saturation in the blood. The device measures the amount of oxygen carrying hemoglobin in the blood relative to the amount of hemoglobin not carrying oxygen. Widely used in research and it showed to be valid and reliable [14].

Outcome measures:

- Lung capacity Tidal volume and IRV by spirometer
- oxygen saturation in the blood
- Heart rate

Procedures

The subjects who met our inclusion criteria asked to sign a consent form after explanation of the study protocol. Age, weight, and height were recorded for each participant. A new incentive spirometer was provided to all the participants. the baseline measurements include the oxygen saturation in the blood, lung inspiratory capacity (TV+IRV), and heart rate. Each participant was instructed how to do the breathing exercises (pursed lip breathing).



Figure 1. Incentive spirometer



Figure 2. Pulse oximeter

Oxygen saturation measurements: The measurement recorded with pulse oximeter, with great care to ensure that the test subject's fingers are warm during the testing. Measurements were performed when the subject is awake, not exercised prior the measurements, and have been sitting for ≥ 10 min in the same position, and after an interval of ≥ 1.5 h since the last meal.

Pulmonary rehabilitation protocol: The study focused on pursed lip breathing due to the effectiveness of this exercises in the previous studies [10].

The exercise starts by asking the participant to relax his neck and shoulder muscles and to be in comfortable position, by keeping the lip pressed together tightly, then were asked to inhale as much as possible by their nose in slowly manner, then exhale slowly by their mouth with pursed lips, they were asked to repeat the exercise 5 times. Each participant was measured pre- and post-the exercises. The measurements include oxygen saturation, lung inspiratory capacity, and heart rate.

Data management and analysis

Data collection

During the study time, all the collected data were dealt in confidentiality and stored electronically in Microsoft Excel program of the researcher personal laptop secured with password. In addition, no person has access to data except the researchers. After completion of the study, data will be published collectively with no pointing to participant's identities.

Data analysis

For the statistical analyses IBM SPSS software was used, with significant level of $P < 0.05$ and confidence level of 95%.

The paired t-test was performed to compare the means pre- and post-the breathing exercises in the following variables:

Oxygen saturation, lung inspiratory capacity, and heart rate.

Results

30 participants with confirmed diagnosis of covid-19 were enroll in the experimental study. Table 1 illustrate the participants characteristics.

Tables 2 and 3 shows the results pre- and post-the breathings exercises, The result demonstrate significant differences in spo2 from 89.9 pre the exercises increased to 92.8 percentage post the exercises. In addition, the inspiratory lung volume increased from 2450 ml to 2723 ml after the exercises.

Discussions

The study aimed to investigate the effect of pulmonary rehabilitation on covid-19 patients. The pulmonary rehabilitation involved breathing exercises and techniques, these exercises were used in previous researches and showed effective in treating and decreasing the symptoms of various pulmonary conditions [2]. The aforementioned results showed that pursed lip breathing exercise showed significantly effective in increasing the lung inspiratory volume and spo². The present study results are agreed with previous studies that have used the same technique in pulmonary conditions chronic and acute cases [10,11]. However, our findings only showed the immediate effect of the exercises for the short time. There were some limitations in the study such as: the majority of our participants were males, another limitation our participants were different in the severity of the symptoms. Finally, we did not include the highly sever cases of covid-19 patients in the study.

Table 1. Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	30	24.00	75.00	60.6667	10.78100
Height (cm)	30	160.00	180.00	167.2333	5.95780
Weight (kg)	30	60.00	86.00	69.6000	7.40736
Body mass index (kg/m2)	30	21.51	29.76	24.8777	2.42628

Table 2. Paired samples test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	heart rate pre bpm - heart rate post bpm	-2.63333-	1.18855	.21700	-3.07714-	-2.18952-	-12.135-	29	.000
Pair 2	oxygen saturation pre spo2 - oxygen saturation post spo2	-2.93333-	1.79911	.32847	-3.60513-	-2.26154-	-8.930-	29	.000
Pair 3	lung inspiratory capacity pre ml - lung inspiratory capacity post ml	-273.33333-	309.54175	56.51433	-388.91812-	-157.74855-	-4.837-	29	.000

Table 3. The result demonstrates significant differences in spo² from 89.9 pre the exercises and the inspiratory lung volume increased from 2450 ml to 2723 ml after the exercises.

	N	Minimum	Maximum	Mean	Std. Deviation
heart rate pre bpm	30	66.00	100.00	80.0333	9.47040
heart rate post bpm	30	70.00	101.00	82.6667	9.11359
oxygen saturation pre spo2	30	77.00	96.00	89.8667	5.51320
oxygen saturation post spo2	30	81.00	99.00	92.8000	5.23516
lung inspiratory capacity pre ml	30	500.00	5000.00	2450.0000	1676.92247
lung inspiratory capacity post ml	30	500.00	5000.00	2723.3333	1527.32205

Clinical implications

The study showed that pursed lip breathing exercise were effective in increasing inspiratory lung volume and spo₂. Therefore, decrease the independence in the ventilators.

Conclusion

The study showed that the pulmonary rehabilitation and especially pursed lip breathing techniques were helpful in increasing the inspiratory lung volume and spo₂. There were significant differences after the exercises.

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Authors' Contributions

All authors contributed to the study design, methodology, data acquisition and analysis. In addition, all authors drafted and revised the article. Finally, all authors approved the submitted version.

References

1. Diagnosis and Treatment Guideline for Novel Coronavirus Pneumonia (2020) The People's Republic of China: National Health Commission of the People's Republic of China, General Office of the National Health Commission.
2. Spruit MA, Singh SJ, Garvey C, ZuWallack R, Nici L, et al. (2013) An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. *Am J Respir Crit Care Med* 188: e13-64. [[Crossref](#)]
3. Tortora, Gerard J (2016) Principles of anatomy & physiology.
4. Santino TA, Monteiro KS, de Paiva Azevedo M, Patino CM, Ahmed S, et al. (2020) Patient- and proxy-reported outcome measures instruments for the assessment of asthma control among adult and pediatric population. *Medicine* 99: e20078. [[Crossref](#)]
5. Elkhateeb NB, Elhadidi AA, Masood HH, Mohammed AR (2015) Pulmonary rehabilitation in chronic obstructive pulmonary disease. *Egyptian J of Chest Dis Tubercul* 64: 359-369.
6. Wu W, Guan L, Zhang X, Li X, Yang Y, et al. (2017) Effects of two types of equal-intensity inspiratory muscle training in stable patients with chronic obstructive pulmonary disease: A randomised controlled trial. *Respir Med* 132: 84-91. [[Crossref](#)]
7. Beaumont M, Forget P, Couturard F, Reyckler G (2017) Effects of inspiratory muscle training in COPD patients: A systematic review and meta-analysis. *Clin Respir J* 12: 2178-2188. [[Crossref](#)]
8. Kriemler S, Radtke T, Christen G, Kerstan-Huber M, Hebestreit H (2016) Short-Term Effect of Different Physical Exercises and Physiotherapy Combinations on Sputum Expectoration, Oxygen Saturation, and Lung Function in Young Patients with Cystic Fibrosis. *Lung* 194: 659-664. [[Crossref](#)]
9. Yang LL, Yang T (2020) Pulmonary Rehabilitation for Patients with Coronavirus Disease 2019 (COVID-19). *Chronic Dis Transl Med* 6: 79-86. [[Crossref](#)]
10. Jansang S, Mickleborough T, Suksom D (2016) Effects of Pursed-Lip Breathing Exercise Using Windmill Toy on Lung Function and Respiratory Muscle Strength in the Elderly. *J Med Assoc Thai* 99: 1046-1051. [[Crossref](#)]
11. Ublakka-Jones C, Tongdee P, Pachirat O, Jones DA (2018) Slow loaded breathing training improves blood pressure, lung capacity and arm exercise endurance for older people with treated and stable isolated systolic hypertension. *Exp Gerontol* 108: 48-53. [[Crossref](#)]
12. Jiang Y, Chen J, Cen F, Li X, Song Z, et al. (2020) Importance of respiratory airway management as well as psychological and rehabilitative treatments to COVID-19 patients. *Am J Emerg Med* 38: 1698.e1-1698.e4. [[Crossref](#)]
13. Bastin R, Moraine JJ, Bardocksky G, Kahn RJ, Mélot C (1997) Incentive spirometry performance. A reliable indicator of pulmonary function in the early postoperative period after lobectomy?. *Chest* 111: 559-563. [[Crossref](#)]
14. Muñoz X, Torres F, Sampol G, Ríos J, Martí S, et al. (2008) Accuracy and reliability of pulse oximetry at different arterial carbon dioxide pressure levels. *Eur Respir J* 32: 1053-1059. [[Crossref](#)]