

# Studying the effect of chest expansion exercises on arterial blood oxygen saturation in hospitalized patients with COVID-19: A randomized clinical trial study

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## ABSTRACT

Decreased arterial blood oxygen saturation is one of the most common complications of COVID-19. Considering the major respiratory problems of infected individuals and the role of respiratory physiotherapy in reducing respiratory complications, this study aimed to determine the effect of chest expansion exercises on arterial blood oxygen saturation in hospitalized patients with COVID-19. This study is a randomized, single-blind clinical trial study conducted on 42 hospitalized patients with COVID-19 at Bu Ali Hospital in Zahedan. Patients were randomly assigned to two intervention groups (n=21) and control groups (n=21). The control group was treated with routine breathing exercises (diaphragmatic breathing and pursed lip breathing). In the intervention group, patients received chest expansion exercises in addition to routine breathing exercises. Treatment for both groups was performed for 7 days (7 times a week) and 3 sessions each day (morning-noon-evening) and each exercise was performed 10 times. Then, the outcomes were recorded once before the start of the exercises, once in the fourth session and once after the end of the 7 treatment sessions, that is, in the eighth session. Arterial blood oxygen saturation (SPO<sub>2</sub>) was measured and recorded by a finger pulse oximeter. The results showed that in the intervention group, the average arterial blood oxygen saturation after treatment was statistically significantly different from before treatment ( $P < 0.05$ ). In the control group, the average arterial blood oxygen saturation after treatment was not statistically significantly different from before treatment ( $P > 0.05$ ). The results also indicated that the effect of time on the arterial oxygen saturation of patients was significant ( $P < 0.05$ ), meaning that the average SPO<sub>2</sub> between the intervention and control groups changed significantly over time. Chest expansion exercises played an important role in increasing the arterial oxygen saturation of patients with COVID-19. It is recommended that these exercises be performed for other respiratory patients who suffer from reduced arterial oxygen saturation.

**Keywords:** COVID-19, Chest expansion exercises, Arterial oxygen saturation

## Introduction

In mid-December 2019, cases of pneumonia caused by an unknown virus were reported in China [1]. The disease was initially described in China as a mysterious respiratory illness and was later named COVID-19 by the World Health Organization (WHO) [2]. COVID-19 is caused by a novel coronavirus (SARS-CoV-2) that has not previously been reported in humans [3, 4]. The World Health Organization (WHO) declared COVID-19 a public health emergency of international concern, as the

contagious coronavirus rapidly spread worldwide [2]. Given that one of the important systems targeted by the coronavirus is the respiratory system, and its complications include things like reduced lung volume and reduced arterial blood oxygen saturation, and in more severe cases of the disease, infections caused by viral pneumonia may lead to acute respiratory distress syndrome (ARDS), therefore, the role of physiotherapists, especially in the field of respiratory physiotherapy, along with other health professionals, in the treatment and care of this group of patients and overcoming the respiratory symptoms of affected

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patients is important [5]. Respiratory physiotherapy includes specific breathing exercises and exercises that are planned and performed in order to achieve effective and controlled ventilation, reduce the work of breathing, and correct respiratory defects. These exercises fill the alveoli with air to the maximum extent possible, cause muscle expansion, eliminate anxiety, eliminate inappropriate patterns of respiratory muscle activity, and reduce the respiratory rate [6]. Given the fact that COVID-19 is a new and emerging disease, there are few scientific and documented findings in this field. Therefore, given the impact of this disease on the respiratory system of infected patients, specialized findings on the improvement of pulmonary patients and their summary are very helpful in advancing the goals. A study conducted in 2020 by Lazzeri pointed out the importance of the role of respiratory physiotherapy in patients with COVID-19 [7]. In 2019, Liu *et al.* used breathing exercises to reduce respiratory disorders caused by the coronavirus in elderly Chinese patients. In this study, 6 weeks of respiratory rehabilitation exercise had a significant effect on improving shortness of breath and oxygen deficiency in patients [8]. Studies have also been conducted on the effectiveness of respiratory physiotherapy in various diseases involving the lungs. Mei He and colleagues conducted a study on the effectiveness of respiratory physiotherapy on 96 patients with chronic obstructive pulmonary disease with acute involvement. Rehabilitation interventions were performed from the second day of hospitalization. The results indicated that the arterial blood oxygen saturation (SPO<sub>2</sub>) in patients with rehabilitation intervention significantly improved [9]. In another study, Kilic *et al.* examined the effect of 18 sessions of pulmonary physiotherapy on patients who were candidates for lung transplantation. The results showed that respiratory rehabilitation interventions significantly improved pulmonary symptoms, reduced shortness of breath, and increased respiratory capacity in patients [10]. In general, respiratory physiotherapy includes chest expansion exercises, diaphragmatic breathing, and pursed lip breathing. In patients with COVID-19, where lung volume and respiration are reduced, chest expansion exercises are of particular importance. Chest expansion exercises are exercises that involve active movements of the trunk or limbs. These exercises are designed to maintain or improve the mobility of the chest wall, trunk, and shoulder girdle, open the alveoli, and affect ventilation or postural alignment. These exercises are also used to enhance or emphasize the depth of controlled inhalation or exhalation [6]. Therefore, in a situation where the COVID-19 pandemic threatens the health of human society, and given the lack of articles and limited research projects in this field, and given the major respiratory problems of people with COVID-19, and pointing out the important point that respiratory physiotherapy can be used as an important part of treating and reducing respiratory problems in affected people [11], the aim of the present study was to investigate the effect of chest expansion exercises on arterial blood oxygen saturation in hospitalized patients with COVID-19.

## Materials and Methods

This study is a single-blind randomized clinical trial conducted on hospitalized patients with COVID-19 at Bu Ali Hospital in Zahedan. The study population was all patients with confirmed COVID-19 based on PCR testing who referred to Bu Ali Hospital and had the following inclusion criteria: patients with a confirmed diagnosis of COVID-19 by PCR, blood oxygen saturation level of 75-90% by pulse oximeter, age 25-55 years, pulmonary involvement with a corona pattern on lung CT scan or chest X-ray, patients with at least two lung lobes involved with coronavirus, patients undergoing oxygen therapy, patients treated with remdesivir and dexamethasone, and patients who have not received the vaccine. Exclusion criteria also include: patients admitted to the ICU who require intubation, critically ill patients who are intubated, pregnant women, patients with a history of cardiac arrhythmias and other respiratory diseases that involve the lungs, and tachycardia patients in whom breathing exercises cause an increase in heart rate. In this study, a convenient non-probability sampling method (available) was used. In order to conduct the study on patients with COVID-19, who met the inclusion criteria, necessary explanations were given about the study objectives, and after obtaining informed consent, the samples were entered into the study and were assigned to two intervention and control groups using a stratified block permutation randomization method. The control group underwent routine physiotherapy treatment (diaphragmatic breathing and pursed lip breathing), and the intervention group underwent chest expansion exercises in addition to routine respiratory physiotherapy exercises. A finger pulse oximeter was used to measure the arterial blood oxygen saturation level. After measuring the patients' arterial blood oxygen saturation level, treatment was performed for both groups for 7 days (7 times a week) and 3 sessions each day (morning-afternoon-night), and each exercise was performed 10 times. Then, the arterial blood oxygen saturation level was recorded once before the start of the exercises, once on the fourth day, and once after the end of the 7 treatment sessions, that is, on the eighth day. In the control group, the patient was taught diaphragmatic breathing exercises and pursed lip breathing from the first day of the exercises. In the intervention group, the patient was taught the first, second, and third chest expansion exercises on the first day of the exercises. The fourth exercise was also taught to the patient on the second day and the fifth exercise on the third day. Also, in the intervention group, in addition to expansion exercises, the patient was taught diaphragmatic breathing exercises and pursed lip breathing from the first day. Explanations and images of how to perform the breathing exercises were prepared from reliable scientific sources, and their content validity was confirmed by professors and experts.

Exercise 1) First, we ask the patient to sit on his bed and place his hands crossed in front of his stomach. When inhaling, he spreads his hands apart (away from the torso) and when exhaling

(through the mouth), he brings his hands forward and to the middle (closer together) (Figure 1).

Exercise 2) First, we ask the patient to sit on his bed and place his hands in the air in front of his body. When inhaling (through the nose), he moves his hands back (away from each other), and when exhaling (through the mouth), he brings his hands forward and closer together in the middle (Figure 2).

Exercise 3) We ask the patient to sit on his bed and place his hands straight and flat in front of him, then while inhaling (through the nose) raise his hands vertically above his head (180 degrees of flexion) and while exhaling through the mouth, bring his hands down (Figure 3).

Exercise 4) First, we ask the patient to sit on his bed and clasp his hands behind his head, and while inhaling through his nose, move his hands backward (horizontal abduction), and while exhaling through his mouth, bring his elbows together (Figure 4).

Exercise 5) Ask the patient to place their hands on their shoulders while sitting, then move their hands back while inhaling through their nose and bring their hands forward while exhaling through their mouth (Figure 5) [6].

In this study, a single-blind method was used, so that the technician responsible for recording the outcome was not aware of the intervention in question. At the end of the seven days of the intervention, the results were compared with each other according to the objectives. After collecting the information, the raw data were entered into the SPSS version 24 statistical software for analysis. To compare the average variables between the two groups, if the assumptions of parametric tests were met, the t-test for two independent groups was used, and if the assumptions were not met, alternative non-parametric tests such as the Mann-Whitney test were used. To compare the proportions between the groups (testing the assumption of independence), the chi-square test was used. To compare the average variables between the two groups and to examine the effect of time and control for possible confounders, if the assumptions were met, the repeated measures Anova analysis was used. Data analysis was performed with a confidence interval of 95% and at a significance level ( $P < 0.05$ ). Also, ethics permission was obtained from the Ethics Committee of Zahedan University of Medical Sciences under the number IR.ZAUMS.REC.1401.070. The trial registration number for this study is IRCT20220611055133N1.

## Results and Discussion

In the present study, 42 patients with COVID-19 were studied in two intervention (21) and control (21) groups, with a mean age of  $44.26 \pm 7.43$ . 20 (47.6%) of the participants were female and 22 (52.4%) were male. The results of the Mann-Whitney test showed that the mean number of lobes involved was not statistically significant ( $P = 0.834$ ) and the two groups had a normal distribution.

The extent of lung lobe involvement in the study participants was as follows: involvement of the right and left lower lobes

28.6%\_upper middle lower right and lower left lobes 23.8%\_upper left and lower right and left lobes 33.3% and 14.3% of the patients had all lung lobes involved.

According to Table 1 and based on the results of the repeated measures analysis of variance test, it was determined that the effect of time on the arterial blood oxygen saturation of patients was significant, meaning that the average arterial blood oxygen saturation of patients changed significantly over time ( $P < 0.05$ ). The average arterial blood oxygen saturation between the two intervention and control groups was statistically significant in the third stage, that is, on the eighth day after treatment ( $P < 0.05$ ). That is, the intervention was effective on the eighth day.

Table 1 : Mean and SD of Arterial oxygen saturation before & 4 and 8 days after treatment

Groups Stage	Index	Before studying	Day Four	Day Eight	P Value
Intervention	Mean	83.40	88.04	92.09	0/04
	SD	4.02	3.24	1.84	
	Median	85	89	92	
Control	Mean	84.95	86.66	88.90	0/33
	SD	3.07	2.87	2.48	
	Median	86	89	89	
P Value		0/32	0/45	P < 0/001	

The present study was conducted to determine the effect of chest expansion exercises on arterial blood oxygen saturation in hospitalized patients with COVID-19. The results showed that chest expansion exercises had an effect on arterial blood oxygen saturation in hospitalized patients with COVID-19, such that in the intervention group, the mean arterial blood oxygen saturation increased compared to the control group after performing chest expansion exercises, and there was a statistically significant difference ( $P < 0.05$ ). Other previous studies also showed similar results, for example, Kader *et al.* (2021) in their study aimed at the effect of short-term breathing exercises on improving the respiratory status of 173 Swedish patients with COVID-19 concluded that breathing exercises, even for a short period of time, are effective in improving some respiratory parameters in patients with COVID-19, such as respiratory rate and blood oxygen saturation level (Spo2) [12]. Also, according to the 2020 guideline for physiotherapists in the treatment of hospitalized patients with COVID-19, breathing exercises play an effective role in increasing the oxygen saturation level of patients' arterial blood and improving their respiratory status [13]. In addition, Liu *et al.* (2020) also showed in a study of elderly patients with COVID-19 in China that six weeks of breathing exercises can improve respiratory function and quality of life in patients with COVID-19 [8]. The results also showed that the effect of time on the arterial blood oxygen saturation of patients with COVID-19 was significant, meaning that the average arterial blood oxygen saturation of patients changed significantly over time ( $P < 0.05$ ). The findings of the present study also showed that the comparison of the two groups after the intervention had a statistically significant difference in terms of arterial blood oxygen saturation, so that the average

arterial blood oxygen saturation between the intervention and control groups in the third stage, i.e. on the eighth day after treatment, became statistically significant ( $P < 0.05$ ). In other words, performing chest expansion exercises increased arterial blood oxygen saturation in hospitalized patients with COVID-19. Also, the results of studies by Cengiz *et al.* (2022) in Turkey [14] and Ahmed *et al.* (2022) in Pakistan [15] showed that breathing exercises are effective on the respiratory status of patients with COVID-19. In addition, in other similar studies, breathing exercises are effective as a safe and effective method in improving the respiratory status of pulmonary patients. Studies by Lu *et al.* (2020) [16], Grobois *et al.* (2019) [17] and Saetan *et al.* (2020) [18] have also shown the effect of breathing exercises on increasing arterial blood oxygen saturation and improving the respiratory status of patients with respiratory diseases including COPD, asthma and lung cancer. The results of these studies are consistent with the findings of the present study because a decrease in arterial blood oxygen saturation in patients with COVID-19 occurs due to alveolar damage, decreased lung volume and respiratory capacity, pulmonary infection and muscle fatigue. Chest expansion exercises can increase arterial oxygen saturation in patients with COVID-19 by improving mobility of the chest wall, trunk, and shoulder girdle, opening the alveoli, enhancing inspiratory depth, improving oxygen and carbon dioxide exchange, increasing respiratory capacity and lung volume, facilitating lung clearance of infectious secretions, and also by affecting ventilation or postural alignment of the trunk [6]. However, it seems that more and more diverse studies are still needed in this field to achieve the best exercise protocol and the best duration of exercise to achieve the desired result.

## Conclusion

The results of this study showed that chest expansion exercises had a positive effect on arterial blood oxygen saturation in hospitalized patients with COVID-19. Also, considering the decrease in arterial blood oxygen saturation in patients with coronavirus, training and correct performance of these exercises by improving oxygen and carbon dioxide exchange and opening the alveoli can be an important part of the care of patients with COVID-19, leading to improvement in the patient's respiratory status. Finally, it was concluded that, considering the major respiratory problems of patients with COVID-19, chest expansion exercises can be an important part of the treatment and reduction of respiratory problems of patients and can be a useful tool for hospitals, physiotherapists, nurses and patient caregivers to use in the COVID-19 epidemic.

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**Conflict of interest:** None

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**Ethics statement:** The medical ethics committee at Zahedan University of Medical Sciences approved the study ethics and issued the ethics certification number as IR.ZAUMS.REC.1401.070 and registered with the region's Clinical Trials Registry (IRCT20220611055133N1).

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