



## Pulmonary Rehabilitation Program for Elderly Persons Recovered from COVID-19 to Restore Normal Pulmonary Function and Quality of Life

Sameer Hamdy Hafez <sup>1</sup>, Hayam, Ahmed Mohamed <sup>2</sup>, Noha Ahmed Mohamed <sup>3</sup>

<sup>1</sup>nursing/ community health nursing, faculty of nursing, Beni-suef University, Egypt,

<sup>2</sup> nursing/ Department of medical surgical nursing, faculty of nursing, Benha university, Benha, Egypt

<sup>3</sup> nursing/ community health nursing, faculty of nursing, Beni-suef University, Egypt

### ABSTRACT

Elderly persons experience more persistent health problems after recovering from COVID-19 than younger adults. The present study **aimed** to evaluate the effectiveness of pulmonary rehabilitation program for elderly persons recovered from COVID-19 to restore normal pulmonary function and quality of life. **Design:** A quasi experimental design was used. **Setting:** The study was conducted at the university hospitals in Beni-Suef and Benha City. **The sample:** convenience sample included 90 elderly persons recovered from COVID-19. **Tools:** three tools were used; tool (I): interviewing questionnaires composed of three parts; part1: personal characteristics of the elderly persons, part 2: Older People's Quality of Life Questionnaire, part3: The Manchester Respiratory Activities of Daily Living Questionnaire. The second tool was geriatric depression scale. The third tool was the spirometer. **The main results** indicated that; the pulmonary function parameters, mean scores of quality of life and daily living activities among the intervention group after implementing the intervention were significantly higher than the control group ( $P < 0.05$ ). While regarding the depression level, there were no significant differences between the two groups. **Conclusion:** the pulmonary rehabilitation program effectively improved pulmonary function, ability to perform daily living activities, and quality of life significantly and reduced depression among the studied older adults but with no significant differences. **Recommendations:** Pulmonary rehabilitation should be an integral part of the post-discharge treatment plan for the older adults.

**Keywords:** COVID-19, elderly persons, pulmonary rehabilitation program, quality of life.

### Introduction

The new coronavirus-2019 (COVID-19) pandemic began in late December 2019 in Wuhan, China, and quickly spread to over 200 nations worldwide. About 20 million diagnosed cases have about 700,000 deaths (World Health Organization, 2020). COVID-19 can cause various symptoms; from no symptoms to life-threatening diseases such as vacuities, myocarditis, severe inflammation at the lung tissue, multi-organ failure, and death (Carfi, Bernabei, Landi, 2020).

The coronavirus disease 19 (COVID-19) epidemic has wreaked havoc worldwide, infecting tens of millions of people and killing over a million people. Approximately 40% of COVID-19 participants develop mild, 40% establish moderate disease, and 5% develop critical illness (Wu and McGoogan, 2019). Major alveolar damage is one of the most common complications of the disease resulting in acute respiratory failure requiring mechanical ventilation in a high proportion of cases (Huang et al., 2020).

The main concern in COVID-19 is the negative effect on the lungs and respiratory system, which can lead to dyspnea, decreased saturation of blood by oxygen, and decline in respiratory function; these conditions increase the need for mechanical ventilation (Khalifa et al., 2020; Lei et al., 2020), especially in those with comorbid conditions like diabetes, obesity, ischemic heart disease, cancer, post-surgery, and chronic obstructive pulmonary disease (COPD) (Guo et al., 2020). Smoking, older age, and pre-existing comorbidities have been linked to worsening COVID-19 symptoms and a higher mortality rate (Zhou, Yu, Du, 2020).

Many individuals still suffer from chronic, clinically significant sequelae 2–3 months after being “cured” of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections. New illness-related fatigue (53–87 percent), dyspnea (43–71 percent), or cognitive impairments (47 percent) are among the most commonly reported health difficulties, with a high incidence of psychological disorders such as increased anxiety, stress, and depression (Halpin, McIvor, Whyatt, 2021). According to numerous international expert organizations, complete and multidisciplinary rehabilitation, such as pulmonary rehabilitation, should be delivered to COVID-19 patients based on their unique weaknesses, emphasizing treating respiratory, physical, and psychological impairments. (Spruit, Holland & Singh, 2020).

According to the American Thoracic Society (ATS)/European Respiratory Society (ERS) Statement, pulmonary rehabilitation is a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, such as exercise training, health education, and lifestyle change, designed to improve the physical activity, pulmonary function, quality of life, and stress level of patients with

chronic respiratory disease, as well as to promote the long-term adhesion of the patient to the treatment regimen (Vogiatzis et al., 2016). For the greater good, PR is seen as an essential component of complete patient treatment, and it is often dependent on the participation of the whole healthcare team to achieve the best possible results (McCarthy et al., 2015).

Quality of life is defined as a perception of persons regarding their role and position in life with the consideration to the culture and value systems in their environment and in relation to their aims, expectations and concerns. Elderly patients with COVID-19 seem to be the more susceptible to negative impact on the quality of life at 6 months following discharge because of the persistent symptoms as dyspnea, fatigue, cough and shortness of breath (Tessitore and Mach, 2021). The elderly patients after the discharge in need to interdisciplinary comprehensive care as pulmonary rehabilitation (PR) including education, motivational support, and physical activity training and it is considered the main non-pharmacological component of respiratory problems treatment. The effectiveness of PR on respiratory problems, health-related quality of life, emotional function and exercise capacity have been repeatedly confirmed but the participation rate from the elderly patients to (PR) programs still low (Gephine, Le Rouzic, Machuron, Wallaert, Chenivresse, et al., 2021).

#### Significance of the study

Half of the elderly patients after discharge from the hospital, with severe COVID-19 need pulmonary rehabilitation (Curci, Pisano & Bonacci, 2020; Salawu et al., 2020). Traditional forms of rehabilitation were used throughout the epidemic due to social and physical constraints and worries about the spread of SARS-CoV-2 in the community. As stated in worldwide guidelines and recommendations for treating

COVID-19 patients, the tolerance and effects of pulmonary rehabilitation programs are yet unclear. COVID-19 old age patients are becoming more common; thus, we cannot wait for well-designed randomized controlled trials to be published before using these medicines in regular clinical practice (Singh, Agusti, Anzueto, 2019; Alqahtani, Oyelade, Aldhahir, 2020).

The study aimed to evaluate the effectiveness of pulmonary rehabilitation program for elderly persons recovered from COVID-19 to restore normal pulmonary function and quality of life through achieving the following objectives:

1. Increase exercise capacity in order to reduce activity limitations and increase pulmonary function parameters among the intervention group.
2. Improve quality of life among the intervention group.
3. Upgrade functional ability to perform daily living activities among the intervention group.
4. Decrease level of depression among the intervention group.

### Study hypothesis

1. The pulmonary function parameters among the intervention group are significantly higher than in the control group after implementing the pulmonary rehabilitation program.
2. The mean score of quality of life among the intervention group is significantly higher than in the control group after implementing the pulmonary rehabilitation program.
3. The mean score of daily living activity among the intervention group is significantly higher than in

the control group after implementing the pulmonary rehabilitation program.

4. The level of depression among the intervention group is significantly lower than in the control group after implementing the pulmonary rehabilitation program.

### Subjects and method

#### Research design

The researchers used the quasi experimental design (case / control) to achieve the aim of the present study.

#### Research Setting:

The study was conducted at the university hospitals in Beni-Suef and Benha City.

#### Study sample:

Convenience sample of 90 elderly persons discharged from the internal medical department of Beni-Suef and Benha university hospitals, in the period from March 2020 to July 2020 and fulfill the inclusion criteria were included in the study. The subjects were randomly classified to intervention group and control group.

#### Inclusion criteria

- All elderly persons who were  $\geq 60$  years from both genders.
- Discharged with mild or moderate pulmonary function impairment
- Demonstrated physical ability to participate, be motivated and committed to the prescribed pulmonary rehabilitation program
- Didn't need oxygen support therapy

**Tools of data collection**

Three tools were designed to collect data:

**Tool (I): Structured questionnaires composed of 3 parts**

**Part1: personal characteristics of the elderly persons:** as age, gender, educational level and residence

**Part2: Older People’s Quality of Life Questionnaire (OPQOL)**

The (OPQOL) was adopted by the researchers and is composed of 35 items (5-1) strongly agree to strongly disagree to assess the quality of life for elderly.

**Scoring system:**

The total scores ranges from 35-worst possible QOL to 175-best possible QOL. OPQOL validity and reliability have been properly established. Cronbach’s alpha coefficient ranged from 0.748 to 0.901 across the sub-groups (Rathnayake and Siop, 2015).

**Part3: The Manchester Respiratory Activities of Daily Living Questionnaire (MRADL):**

The tool was adopted by the researchers; it is a self-reported questionnaire, composed of 21-items to assess respiratory activities of daily living of the elderly patient. It has four domains: Mobility (7 items), Kitchen activities (4 items), Domestic tasks (6 items), and Leisure activities (4 items). **Scoring system:** The MRADL is scored compositely in the range 0 to 21, with a score of 21 signifying no physical impairment. The test–retest reliability as indicated by an intra-class correlation coefficient value of 0.975 (Siu et al., 2020).

**Tool (II): Geriatric Depression Scale (GDS):**

The tool was adopted by the researchers to assess the level of depression among elderly patients. The GDS was found to have 92% sensitivity and 89%

specificity when evaluated against diagnostic criteria. The validity and reliability of the tool have been supported through both clinical practice and research (Cronbach’s alpha coefficient was 0.84).

**Scoring system:** It composed of the 15 items, 10 indicated the presence of depression when answered positively, while the rest (question numbers 1, 5, 7, 11, 13) indicated depression when answered negatively. Scores of 0-4 are considered normal, depending on age, education, and complaints; 5-8 indicate mild depression; 9-11 indicate moderate depression; and 12-15 indicate severe depression (Greenberg, 2012).

**Tool (III) Spirometer:**

It used to measure how much air the patient can breathe in and out of lungs, as well as how easily and fast the patient can blow the air out of lungs.

**Parameters of pulmonary function test**

Spirometer test	Normal	Abnormal	
		Mild	Severe
A. forced vital capacity (FVC)	Equal to or greater than 80%	Mild	70-79%
B. forced expiratory volume-one second (FEV1)		Moderate	60-69%
		Severe	>60%
C. FEV1/FVC	Equal to or greater than 70%	Mild	60-69%
		Moderate	50-59%
		severe	Less than 50%

The spirometer device has high validity and reliability to measure pulmonary function (Sooriyakanthan, Wimalasekera, and Kanagasabai, 2019) and (Kim and Lee, 2020).

**Validity and reliability**

A panel of five Faculty members of community health nursing and medical surgical nursing department reviewed the previous tools and confirmed its validity. The tools proved to be strongly reliable.

**Approval:**

An official permission was obtained from the official personnel in Beni-Suef University hospital and

Benha University hospital to conduct the study and collect the necessary data. Simple explanation was given to them about the nature of the study, its aims, benefits and study data collection tools.

#### **Ethical considerations:**

The study was conducted with careful attention to ethical standards of research and rights of participants. The researchers explain the aim and nature of the study to the participants then the oral consent was taken. The participants were informed that the data collected will be used for the research only, and confidentiality manner is assured as well they informed that they can withdraw at any time from the study.

#### **Pilot Study**

A pilot study of ten patients was conducted to evaluate the questionnaire's content and time requirements for data collection. Patients who participated in the pilot trial were excluded.

#### **Procedures**

##### **Assessment phase:**

- The researchers meet the participants and explain the aim and the procedures of the study. The researcher get the oral consent from the participants then classified them to intervention group and control group.
- The researchers collected the pretest data
- The researchers explain the components of the program to the participants

##### **Components of the program**

- Exercise and inspiratory muscle training
- Aerobic exercise as walking, stretching exercise
- Respiratory exercises as pursed lip exercise, diaphragmatic breathing exercise, humming while exercise and forced coughing

- Psychosocial counseling ( training on stress management strategies)
- Nutritional education
- Health education about prescribed medication and its use
- The researchers develop and distribute an booklet with coloured photos contains all elements of the program and simple steps of how to perform the exercises

##### **Implementation phase**

- The researchers plan for two visits per week at the outpatient clinics or at the home of the participants.
- The intervention lasted for 8 weeks
- The researchers at each visit train the participants on the training exercises and ask them to perform endurance training for 20 minutes, resistance / strength training for 20 minutes and 30 minutes for the respiratory exercises
- The progression was tailored according to the capacity of each participants
- The researchers ask the participants to do this cycle for other two days of the week
- The researchers assess the nutritional habits of the participants then give health education to modify nutritional habits according to the recommended therapeutic nutrition for COVID-19.
- The researchers train the participants to avoid the stressful condition and how to use the stress management strategies
- Each visit ranged from 100 minute to 120 minute

##### **Evaluation phase**

At the end of intervention period post-test was performed.

##### **Statistical analysis:**

The statistical analysis was carried out on a computer according to the quantity and percentage

distribution of the collected data. It was determined that the mean and standard deviations were obtained. The SPSS version 20 statistical package for social science software (SPSS) was used to evaluate whether there were statistically significant differences (chi-square and T-test). P-values of 0.05 were considered statistically significant.

**Results**

Table (1) reveals that 55.6% of the intervention group are males compared to 60% of control group and 40% of the intervention group their ages ranged from 60> to 65 years compared to 46.7% in the control group. Regarding to the educational level, 28.9% have high education and 44.4% of them have primary education in the intervention group compared to 26.7% and 37.7% respectively in the control group and 62.2% of them reside in rural areas in intervention group compared to 53.3% in control group. As general there are no significant differences in all items of personal characteristics between intervention group and control group.

Table (2) shows that there are no significant differences between the two groups regarding FEV1, FVC and FVC/FEV1 ratio pre intervention, where p > 0.05.

Table (3) illustrates that the mean scores of all parameters among intervention group are significantly higher than those in control group, p value is 0.00001 at all parameters.

Table (4) denotes that the mean score of quality of life among the intervention group is 126.6±10.1 compared to 104.1±16.08 among the control group post intervention. This difference is significant according to the P value (0.0001). The table added that the mean score of daily living activities among the intervention group is 15.3 ±1.4 compared to 12.7±1.1 among the

control group post-implementing the pulmonary rehabilitation program with significant difference (P value < 0.0001).

Table (5) regarding the levels of depression, the data clarifies that 53.3 % of the elderly persons at the intervention group is normal post intervention compared to 35.55% at the control group. The data added that 24.4% of the intervention group suffers from mild level of depression compared to 20% at the control group. The table shows no significant difference between the two groups regarding level of depression.

**Table (1): Frequency distribution of studied elderly persons according to their personal characteristics**

Items	Intervention(45)		Control (45)		X2	P
	N	%	N	%		
Gender						
Male	25	55.6	27	60.0	0.18	0.66
Female	20	44.4	18	40.0		
Age						
60>65	18	40.0	21	46.7	0.4	0.81
65>70	16	35.6	14	31.1		
≤70	11	24.4	10	22.2		
Education						
Primary	20	44.4	17	37.8	0.85	0.65
Secondary	12	26.7	16	35.5		
High education	13	28.9	12	26.7		
Residence						
Rural	28	62.2	24	53.3	0.72	0.39
Urban	17	37.8	21	46.7		

**Table (2) Comparison between intervention and control group according to severity of pulmonary function impairment pre intervention (N=90)**

Items	Intervention		Control		X2	P
	N	%	N	5		
<b>Forced expiratory volume (FEV1)</b>						
Mild	22	48.88	26	57.77	0.71	0.39
Moderate	23	51.11	19	42.22		
<b>Forced vital capacity (FVC)</b>						
Mild	20	44.44	18	40.00	0.18	0.66
Moderate	25	55.55	27	60.00		
<b>FVC/FEV ratio</b>						
Mild	19	42.22	21	46.66	0.18	0.67
Moderate	26	57.77	24	53.33		

**Table (3) Comparison between intervention and control group according to the mean scores of severity of pulmonary function impairment post intervention**

Items	Intervention		Control		T test	P
	Mean	SD	Mean	SD		
FEV1	78.4	4.9	66.5	6.4	6.8	0.00001**
FVC	82.4	3.4	66.3	5.4	12.2	0.00001**
FVC/FEV1 ratio	74.6	3.7	61.3	2.9	9.8	0.00001**

**Table (4) Comparison between intervention and control group according to the mean scores of quality of life and daily living activities post intervention**

Items	Intervention	Control	T test	P
Quality of life	126.6±10.1	104.1±16.08	15.9	0.0001**
Daily living activities	15.3 ± 1.4	12.7 ± 1.1	5.9	0.0001**

\*\*Highly statistically significant differences at  $P < 0.01$

**Table (5) Comparison between intervention and control group according to their level of depression post intervention**

Items	Intervention		Control		X <sup>2</sup>	P
	N	%	N	%		
Normal	24	53.33	16	35.55	5.1	0.07
Mild	11	24.44	9	20.0		
Moderate	10	22.22	20	44.44		

## Discussion

Several studies reported that after recovery from COVID-19 there are many health problems persist for long time and need special health care as pulmonary impairment, decline in physical activity and decline in quality of life (Zampogna et al., 2021). The current study aimed to evaluate the effectiveness of pulmonary rehabilitation program for elderly persons recovered from COVID-19 to restore normal pulmonary function and quality of life.

Regarding pulmonary function values, the current study revealed that there were significant improvements regarding FEV<sub>1</sub>, FVC and FVC/FEV<sub>1</sub> ratio among the intervention group after implementing the pulmonary rehabilitation. The results of current study were supported by (Gloeckl et al., 2021) who implemented the pulmonary rehabilitation for 50 patients and reported that there were significant improvements regarding measures of lung function such as FVC or FEV<sub>1</sub> after implementing the pulmonary rehabilitation. In the same line (Spielmanns et al., 2021) conducted study on 99 patients following acute care phase of a COVID-19 infection, found that the comprehensive pulmonary rehabilitation was very effective for improving the pulmonary parameters which estimated by the spirometers.

The results of the current study revealed that the mean score of quality of life among the intervention group was significantly higher than the mean score among the control group after implementing the pulmonary rehabilitation. The results of the current study was incongruent with (Hyden et al., 2021) who measured the outcomes of pulmonary rehabilitation for patients after COVID-19. They observed that there were significant improvements with large sizes in physical activity, depression and quality of life. In the same line (Demeco et al., 2020) mentioned that it is necessary to formulate pulmonary rehabilitation programs as early as possible for patients after COVID-19 recovery to restore physical and respiratory function to improve the quality of life. The results of the current study were supported by (Zampogna et al., 2021) found that pulmonary rehabilitation is possible and effective in patients recovering from COVID-19 to improve physical function and restore quality of life.

Regarding daily living activities, the results of current study revealed that the pulmonary rehabilitation program was effective to make significant differences between patients in the intervention group and the other in the control group. The results of the current study were in congruent with (Vaes et al., 2018) who studied the impact of pulmonary rehabilitation on 31 patients with chronic obstructive pulmonary diseases and reported that the pulmonary rehabilitation was effective in oxygen intake and performing daily living activities.

The current study was in the same line with (Girdhar, Agarwal, and Singh, 2018) reported that the pulmonary rehabilitation was significantly associated with improving functional exercise capacity and performing daily living activities among patients with chronic respiratory diseases. In the same line (Liu et al., 2020) conducted a randomized study to evaluate

the effect of pulmonary rehabilitation for post COVID-19 patients reported that there were significant improvement among the intervention group after implementing the pulmonary rehabilitation regarding quality of life and daily living activities.

Regarding impact of pulmonary rehabilitation program on levels of depression, the results of current study revealed a low effect, more than half of the intervention group were normal after implementing the rehabilitation program compared to one third among the control group and about one quarter of the intervention group had moderate level of depression compared to one fifth of the control group but this difference not classified as a significant difference. The results of current study were supported by (Liu et al., 2020) who reported that the pulmonary rehabilitation had significant impact on quality of life of elderly people but it had low significant effect on depression. On the other hand (Gloeckl et al., 2021) found that the pulmonary rehabilitation program had significant impact to improve mental quality of life and depression among patients with severe/critical COVID-19. These differences may be related to the contribution of other factors in elderly persons' life as the environment, social relation and economic status.

### Conclusion

The current study results concluded that the pulmonary rehabilitation program was effective strategy to improve pulmonary function, quality of life, ability to perform daily living activities and to reduce depression level among the older adults recovering from COVID-019. The mean score of pulmonary function, daily living activities and quality of life of the elderly persons among the intervention group was significantly higher than among the control group. Additionally, the level of depression among the

intervention group was lower than among the control group but the differences not significant.

### Recommendations:

Pulmonary rehabilitation should be an integral part of the post-discharge treatment plan for the older adults.

Allocating a pulmonary rehabilitation clinic within hospitals and primary health care centers is recommended.

Further studies aimed at assessing the impact of pulmonary rehabilitation program on the other age categories.

### References:

1. **Alqahtani JS, Oyelade T, Aldhahir AM. (2020).** Prevalence, severity, and mortality associated with COPD and smoking in patients with COVID-19: a rapid systematic review and meta-analysis. *PLoS One.* 2020; 15 (5):e0233147. doi:10.1371/journal.pone.0233147
2. **Carfi A, Bernabei R, Landi F. (2020).** Persistent symptoms in patients after acute COVID-19. *JAMA* 2020; 324: 603–605.
3. **Curci C, Pisano F, Bonacci E. (2020).** Early rehabilitation in post-acute COVID-19 patients: data from an Italian COVID-19 rehabilitation unit and proposal of a treatment protocol. *Eur J Phys Rehabil Med.* 2020;56(5):633–641. doi:10.23736/S1973-9087.20.06339-X
4. **Demeco A, Marotta N, Barletta M, et al. (2020).** Rehabilitation of patients post-COVID-19 infection: a literature review. *Journal of International Medical Research.* August 2020. doi:10.1177/0300060520948382.
5. **Gephine, S., Le Rouzic, O., Machuron, F., Wallaert, B., Chenivesse, C., Saey, D., Maltais, F., Mucci, P., Grosbois, J.M. (2021).** Long-Term Effectiveness of a Home-Based Pulmonary Rehabilitation in Older People with Chronic Obstructive Pulmonary Disease: A Retrospective Study. *International Journal of Chronic Obstructive Pulmonary Disease.* Volume 15.



6. **Girdhar A., Agarwal P., and Singh A. (2018).** Pulmonary Rehabilitation in Chronic Obstructive Pulmonary Disease. Available at <https://www.intechopen.com/chapters/64166>. Accessed at 20\ 10\2021
7. **Gloeckl R., Leidl D., Jarosch I., Schneeberger T., Nell C., Stenzel N., Vogelmeier C., Kenn K., Koczulla A. (2021).** Benefits of pulmonary rehabilitation in COVID-19: a prospective observational cohort study. *ERJ Open Research* 2021 7: 00108-2021, DOI: 10.1183/23120541.00108-2021.
8. **Greenberg S. (2012):** The Geriatric Depression Scale (GDS). Available at <https://hign.org/consultgeri/try-this-series/geriatric-depression-scale-gds>
9. **Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, (2020).** The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status. *Mil Med Res* 2020;7:11.
10. **Halpin SJ, McIvor C, Whyatt G. (2021).** Post-discharge symptoms and rehabilitation needs in survivors of COVID-19 infection: a cross-sectional evaluation. *J Med Virol* 2021; 93: 1013–1022.
11. **Hayden, M.C., Limbach, M., Schuler, M., Merkl, S., Schwarzl, G., Jakab, K., Nowak, D., Schultz, K. (2021).** Effectiveness of a Three-Week Inpatient Pulmonary Rehabilitation Program for Patients after COVID-19: A Prospective Observational Study. *Int. J. Environ. Res. Public Health* 2021, 18, 9001. <https://doi.org/10.3390/ijerph18179001>.
12. **Huang C, Wang Y, Li X, Ren L, Zhao J, and Hu Y.(2020).** Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet.* 2020;395(10223):497–506.
13. **Khalifa M, Zakaria F, Ragab Y, Saad A, Bamaga A, and Emad Y.(2020).** Guillain-Barré syndrome associated with severe acute respiratory syndrome coronavirus 2 detection and coronavirus disease 2019 in a child. *J Pediatric Infect Dis Soc* 2020;9:510-.
14. **Kim B. and Lee M. (2020).** A study on the clinical usefulness, validity, and test-retest reliability of the Spirokit, a device that combines the pulmonary function test and respiratory muscle strength test. *Physical Therapy Rehabilitation Science* 2020;9:120-30
15. **Lei S, Jiang F, Su W, Chen C, Chen J, and Mei W. (2020).** Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. *EClinicalMedicine* 2020;21:100331.
16. **Liu K., Zhang W., Yang Y., Zhang J., Li Y., and Chen Y. (2020).** Respiratory rehabilitation in elderly patients with COVID-19: A randomized controlled study. *Complementary therapies in clinical practice* 39: 101166.
17. **McCarthy B, Casey D, Devane D, Murphy K, Murphy E. and Lacasse Y. (2015).** Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2015;2:CD003793.
18. **Rathnayake S, and Siop S. (2015).** Quality of life and its determinants among older people living in the rural community in Sri Lanka. *Ind J Gerontol.* 29(2):131–53
19. **Salawu A, Green A, Crooks MG, Brixey N, Ross DH, Sivan M. (2020).** A proposal for multidisciplinary tele-rehabilitation in the assessment and rehabilitation of COVID-19 survivors. *Int J Environ Res Public Health.* 2020;17(13):4890. doi:10.3390/ijerph17134890
20. **Singh D, Agusti A, Anzueto A. (2019).** Global strategy for the diagnosis, management, and prevention of chronic obstructive lung disease: the GOLD science committee report 2019. *Eur Respir J.* 2019;53 (5):1900164. doi:10.1183/13993003.00164-2019.
21. **Siu D. , So C.T., Lau C.W. , Hui E.H. , Fung A., Chan T.M., Chan F.S.F., Chan C.K.F., Chen WPW, Cheung S.H.M., Chan K.P.Y., Poon P. , Cheung M., Chan C., Tse J., Fung V. and Fong K.N.K.(2020).** The Manchester Respiratory Activities of Daily Living Questionnaire: Reliability and Validity of the Chinese Version with Pictorial Enhancement. *International Journal of Chronic Obstructive Pulmonary Disease » Volume 16.*
22. **Sooriyakanthan M. , Wimalasekera S., and Kanagasabai S . (2019).** Establishment of Reference Norms for Lung Function Parameters of Healthy Sri Lankan Tamils. *Volume 2019 |Article ID 2169627 | <https://doi.org/10.1155/2019/2169627>.*
23. **Spielmanns M., Pekacka-Egli A., Schoendorf S., Windisch W., and Hermann M. (2021).** Effects of a Comprehensive Pulmonary Rehabilitation in Severe

Post-COVID-19 Patients. *Int. J. Environ. Res. Public Health*, 18, 2695.  
<https://doi.org/10.3390/ijerph18052695>  
<https://www.mdpi.com/journal/ij>.

24. **Spruit MA, Holland AE, Singh SJ. (2020).** COVID-19: interim guidance on rehabilitation in the hospital and post-hospital phase from a European Respiratory Society and American Thoracic Society-coordinated International Task Force. *Eur Respir J* 2020; 56: 2002197.
25. **Tessitore, E. and Mach, F. (2021).** Impact of COVID-19 on quality of life. *e-Journal of Cardiology Practice - Volume 21*.
26. **Vaes, A., Delbressine, J., Mesquita, R., Goertz, Y., Janssen F., Nakken, N., Franssen, F., Vanfleteren L., Wouters, E.F.M. , and Spruit M. (2018).** The impact of pulmonary rehabilitation on activities of daily living in patients with COPD. *Journal of Applied Physiology*. 126. 10.1152/jappphysiol.00790.2018.
27. **Vogiatzis I, Rochester CL, Spruit MA, Troosters T. and Clini EM. (2016).** Increasing implementation and delivery of pulmonary rehabilitation: key messages from the new ATS/ERS policy statement. *Eur Respir J*. 2016; 47(5):1336–1341. doi:10.1183/13993003.02151-2015.
28. **Wu Z, McGoogan JM. (2019).** Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72,314 cases from the Chinese Center for disease control and prevention. *JAMA*. 2020; 323(13):1239–42.
29. **Zampogna E., Paneroni M., Belli S., Aliani M., Gandolfo A., Visca D., Bellanti M., T., Ambrosino N., Vitacca M. (2021).** Pulmonary Rehabilitation in Patients Recovering from COVID-19. *Respiration* 2021,100:416-422. doi: 10.1159/000514387.
30. **Zhou F, Yu T and Du R. (2020).** Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020; 395: 1054–1062.
31. **World Health Organization, (2020).** Novel coronavirus- China. Geneva, Switzerland: World Health Organization. [http:// www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/\(2020-1-12\)](http://www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/(2020-1-12)).