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ORIGINAL RESEARCH

The Effect of Exercise-Based Pulmonary Rehabilitation on Quality of Life in Recovered COVID-19 Patients; a Quasi-Experimental Study

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Abstract: **Introduction:** The coronavirus disease 2019 (COVID-19) is associated with a variety of physical and emotional disorders, and subsequently lower Quality of Life (QOL). This study aimed to investigate the effect of a 2-week exercise-based pulmonary rehabilitation on clinical characteristics and QOL of severe COVID-19 patients after discharge from intensive care unit (ICU). **Methods:** In this quasi-experimental study, eligible severe COVID-19 cases, who had survived and were discharged from ICU were selected using convenience sampling method. Oxygen Saturation (SpO2), pulse rate, dyspnea, and QOL were evaluated and compared before and after two weeks of exercise-based pulmonary rehabilitation (PR). **Results:** 35 cases with the mean age of 57.86 ± 11.73 (18-75) years were studied (51.4% female). The mean SpO2 increased from 90.41 ± 3.97 to 95.11 ± 1.96% after two weeks of pulmonary rehabilitation (p<0.0001). In addition, the mean pulse rate (98.97±16.23 to 88.91±14.03 pulse/minute; p<0.001) and the mean dyspnea severity (5.6±1.97 to 3.45±1.97; p<0.0001) decreased after two weeks of intervention. Besides, the mean total QOL and its dimensions, including general health (p<0.0001), physical status (p<0.0001), emotional status (p = 0.036), and social function (p<0.0001) of patients, had significantly increased after intervention. **Conclusion:** Based on the findings of this study, it seems that two-week exercise-based pulmonary rehabilitation could be effective in increasing the SpO2, decreasing dyspnea and pulse rate, and improving the QOL of patients with severe COVID-19 after discharge from ICU.

Keywords: COVID-19; Exercise Therapy; Lung; Rehabilitation; Quality of Life

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1. Introduction

The coronavirus disease 2019 (COVID-19) appeared in Wuhan, China in December 2019, and three months later, the World Health Organization declared it a pandemic. At that time, Iran was ranked the third most-affected country in the world. Patients diagnosed with COVID-19 may experience a wide range of clinical manifestations, which are categorized into no symptoms, mild, moderate, severe, and critical symptoms. Fever, dry cough, sore throat, restlessness, muscle and joint pain, nasal congestion, sneezing and running nose, respiratory failure, general systemic dysfunction, and acute respiratory syndrome are some of the known signs and syndromes related to COVID-19 (1-6). It proves that treatment and outcomes of COVID-19 depend on the disease severity (4). Outpatients diagnosed with COVID-19 may experience symptoms for more than four weeks, which is called long COVID-19 (7). Fatigue, dyspnea, muscle pain, weakness, and psychological distress are the most common symptoms in patients with long COVID-19 (6, 7). A vast range of physi-

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cal and psychological disorders, along with decreased quality of life (QOL), are associated with SARS-CoV-2 infection (4, 7-10).

Based on previous studies and guidelines, rehabilitation programs would be effective for patients diagnosed with COVID-19, especially in patients who were hospitalized (2, 5, 11, 12). All these programs, including aerobic exercises, strengthening, and stretching exercises of respiratory muscles may improve cardiorespiratory tolerance and physical function of patients, as well as their quality of life (13). In addition, respiratory exercises, such as diaphragmatic, bud lip, and resistance breathing will help in reducing active coughing in such patients (2, 14). This study aimed to investigate the effect of a 2-weeks exercise-based pulmonary rehabilitation on clinical characteristics and QOL of severe COVID-19 patients after discharge from intensive care unit (ICU).

2. Methods

2.1. Study design and setting

This quasi-experimental study with before-after design, was performed on severe COVID-19 cases, who had survived and were discharged from intensive care unit of Shohada-e-Tajrish Hospital, Tehran, Iran, during 2021. O2 saturation (SpO2), pulse rate, dyspnea, and QOL were evaluated and compared before and after two weeks of pulmonary rehabilitation (PR) in enrolled patients.

The study protocol was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences (Ethics code: IR.SBMU.RETECH.REC.1400.531) and also registered in Iranian Registry of Clinical Trials (IRCT20211201053238N1). Written informed consent forms were signed to participate in the research. Personal information was kept confidential and patients were given an identification code in the questionnaire form, instead of mentioning their name.

2.2. Participants

Being aged between 18 and 75 years, recovered from severe COVID-19, hospitalized to ICU (between 3 to 18 weeks), satisfied to participate in the research, and referred to the department of physical medicine and rehabilitation by pulmonologist and intensive care specialist due to respiratory failure, as well as not receiving any PR before the study were among the inclusion criteria. Patients who had problems with pulmonary massage, including active wounds, fractures and skin disorders in the chest area (15), a history of uncontrolled cardiovascular problems, chronic obstructive pulmonary disease (COPD), renal, neurological, and cognitive problems, acute rheumatic diseases, hypertension, hemoptysis, psychology disorder, and cancer which lead to not being able to do exercises were excluded.

2.3. Data gathering

The data regarding demographic characteristics, SpO2, pulse rate, dyspnea, and QOL were collected for all patients before and after two weeks of pulmonary rehabilitation by trained occupational therapist in Physical Medicine and Rehabilitation clinic. Measurements of SpO2 and pulse rate was done using pulse oximeter (ChoiceMed made in China (with Coefficient of Variation (CV): 0.01)). The level of dyspnea was calculated using valid and reliable Modified Borg scale, which is subjective and rated by the patient from one up to 10 (16). The QOL was measured using SF-36 questionnaire, which has been proven reliable and valid for Iranians by Montazeri with Intra Class Reliability and Coefficients: <0.05 (17). Generally, SF-36 questionnaire investigates the patient in 8 areas (physical status, physical role, body pain, emotional status, emotional role, social function status, fatigue, general health), and consists of eleven parts and 36 multiple choice questions. In this study, general QOL and its' 4 dimensions, including physical status (physical status, physical role, body pain, fatigue), emotional status (emotional status, emotional role), general health, and social function were evaluated.

2.4. Intervention

PR included training to stay in one of 5 sitting or standing comfortable positions and getting head and shoulders down and breathe in and blow out at first through the mouth and after that doing diaphragmatic breathing for 5 minutes to ease shortness of breath, getting lung massages (with cupping and vibratory techniques) (18) and doing 10 kinds of exercises. The exercises consisted of 3 respiratory exercises, including pursed lip in diaphragmatic, shoulder shrugging and rib breathing, 2 upper extremity exercises, reaching arms to the sky and elbows touch, and 5 lower limbs exercises, including hip hiking, knee abduction/adduction in crock lying, foot rocking in sitting, stepping, and squatting in standing position (18, 19) with 10 repeat, in two face to face sessions in the first week (Sundays and Tuesdays for 60 minutes) and the follow up during all the second week. All the enrolled patients were followed up for two weeks.

2.5. Statistical analysis

The study sample size was calculated as 35 based on two variables; SpO2 and QOL, with 95% confidence interval, Power = 80%, and d=0.02 (19). After data gathering and coding, analysis of variances with Wilcoxon and repeated measurement were used to analyze the data in 26-SPSS. SpO2, dyspnea, and emotional status and social function of QOL did not have normal distribution and the Wilcoxon method was used instead of paired t-test. The findings were reported as mean ± standard deviation or frequency (%). $P < 0.05$ was considered as level of significance.

Table 1: Baseline characteristics of studied patients

Variable	Value
Gender	
Female	18 (51.4)
Male	17 (48.6)
Start of disease to the initial assessment (days)	
21-56	18 (51.4)
57-91	14 (40.0)
92-126	3 (8.6)
Marital Status	
Single	4 (11.4)
Married	22 (62.9)
Widowed/Divorced	9 (25.7)
Education	
Illiterate	4 (11.4)
Primary school	14 (40.0)
High school	11 (31.4)
University	6 (17.1)
Job	
Housewife/none	23 (65.7)
Employed	12 (34.3)

Data are presented as frequency (%).

3. Results

3.1. Baseline characteristics of patients

35 cases with the mean age of 57.86 ± 11.73 (18-75) years were studied (51.4% female). The mean Body Mass Index (BMI) of studied cases was 23.31 ± 3.36 kg/m2 and the mean time interval between the start of disease to the initial assessment in hospital was 56.01 ± 25.06 days. Baseline characteristics of patients are presented in table 1.

3.2. Outcomes of Interventions

The mean SpO2 increased from 90.41 ± 3.97 to 95.11 ± 1.96% after two weeks of pulmonary rehabilitation ($p<0.0001$). In addition, the mean pulse rate (98.97±16.23 to 88.91±14.03; $p<0.001$) and the mean dyspnea severity (5.6±1.97 to 3.45±1.97; $p<0.0001$) decreased after two weeks of intervention.

Besides, the mean total QOL and its dimensions, including general health ($p<0.0001$), physical status ($p<0.0001$), emotional status ($p = 0.036$), and social function ($p < 0.0001$) of patients had significantly increased after intervention. Table 2 compares the measured outcomes before and after two weeks of pulmonary rehabilitation in studied cases.

4. Discussion

Based on the findings of this study, it seems that two-week exercise-based pulmonary rehabilitation could be effective in increasing the O2 saturation, decreasing dyspnea and pulse rate, and improving the QOL of severe COVID-19 patients after discharge from intensive care unit.

Restrictive pulmonary changes and reduced diffusion capacity in patients diagnosed with moderate to severe COVID-19 may lead to long-term functional limitations, as well as reduced QOL in such patients. Considering the previous studies, it appears that pulmonary rehabilitations may be helpful for patients diagnosed with acute respiratory distress syndrome as a consequence of COVID-19 (15, 21-23). Overall, beneficial impacts of rehabilitation have been clearly exhibited in a wide range of health conditions, and in patients with pulmonary diseases such as COPD, rehabilitation reduces dyspnea and improves health-related quality of life (24). Since short-term benefits have been reported for PR by patients, to ensure long-term effects, maintenance of physical activity and healthy lifestyles should be enforced by providing personalized home-based rehabilitation programs or referring the patients to long-term rehabilitation outpatient centers with an integrated model of care (6).

A variety of studies revealed that pulmonary rehabilitation improved the SpO2 in patients who survived COVID-19 (5, 18, 19, 25, 26). The present study results were consistent with the mentioned studies. In this study, like the Huang (27) and McGregor (28) studies, the mean pulse rate significantly decreased after rehabilitation programs.

Also, the average pulse rate reduced, in line with the studies by Alahmri (21) and Huang et al. (2004), which showed that the patients recovered pulse rate after rehabilitation (27). Additionally, in this study, the average of dyspnea reduced, which was in line with Huang (27) and McGregor et al.'s findings (28). This improvement was probably not only related to PR but also to the natural recovery process of the disease (29).

Moreover, in terms of quality of life, a significant increase was reported in patients enrolled in the study after two weeks of the exercise-based pulmonary rehabilitation. Like the present study, recent studies demonstrated that pulmonary rehabilitation may improve the quality of life in patients diagnosed with COVID-19 (19, 28, 30). A study conducted by McGregor revealed that pulmonary rehabilitation could improve the general health status of patients with COVID-19 (28). In the present study, exercise-based pulmonary rehabilitation improved the general health status of enrolled patients, as well as other sub-domains of QOL questionnaire. In recent studies, physical status, emotional status, and social function of patients were improved in patients who underwent pulmonary rehabilitation (24, 28, 30, 31).

Severe COVID-19 cases required prolonged ICU stay and intubation; therefore, they had more physical and psychosocial impairments post-ICU, but recovered following PR. Further controlled and long-term studies are required to better understand the role of PR post-COVID-19 (29).

Unfortunately, in this study we faced some restrictions. The

Table 2: Comparing the status of studied variables before and after two weeks of exercise-based pulmonary rehabilitation

Variable	Mean ± SD	P value
SpO2 (%)		
Before	90.71 ± 3.97	<0.0001
After	95.11 ± 1.96	
Pulse Rate (/minutes)		
Before	98.97 ± 16.23	<0.001
After	88.91 ± 14.03	
Dyspnea severity*		
Before	5.6 ± 1.97	<0.0001
After	3.45 ± 1.94	
Quality Of Life (total)#		
Before	35.5 ± 13.73	<0.0001
After	51.05± 20.30	
General Health		
Before	50.95 ± 17.88	<0.0001
After	57.78 ± 17.09	
Physical Status		
Before	1.37 ± 0.79	<0.0001
After	38.85 ± 23.09	
Emotional Status		
Before	49.21 ± 23.61	<0.036
After	57.14 ± 24.63	
Social Function		
Before	40.35 ± 21.88	<0.0001
After	51.42 ± 24.00	

*: using Borg scale; #: using SF-36 questionnaire. SD: standard deviation.

lack of awareness of patients and specialists regarding the role of outpatient's rehabilitation, caused late referral of patients to relevant centers for help and to reduce disease-related complications like dyspnea. Also, due to long-term and heavy hospitalization costs of medical treatment of patients with severe COVID-19 in ICU and having physical and psychological fatigue related to the disease, and also being worried about re-infection or the spread of disease on the way to rehabilitation clinic, time-consuming PR exercises were not welcomed by some patients and they insisted on having just one training session instead of two weeks PR. However, giving educational brochures related to treatment sessions and encouraging the patients to work out through helping them feel recovered after exercises were the strengths of our study.

5. Limitations

It should be mentioned that our study had several limitations, which need to be considered when interpreting findings; firstly, the small sample size of COVID-19 patients that were rehabilitated and also the absence of follow-up after PR due to limited research time and the probability of losing samples; secondly, the lack of a control group of COVID-19 patients post-ICU who were not rehabilitated; and thirdly no causal role of rehabilitation can be assumed with certainty.

6. Conclusion

Based on the findings of this study, it seems that two-week exercise-based pulmonary rehabilitation could be effective in increasing the O2 saturation, decreasing dyspnea and pulse rate, and improving the QOL of severe COVID-19 patients after discharge from intensive care unit.

7. Declarations

7.1. Acknowledgments

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7.2. Authors' contributions

Leila Angooti carried out the process of data gathering. Leila Angooti wrote the manuscript with support from Mansoor Rayegani, and Rama Bozorgmehr. Mansoor Rayegani, Rama Bozorgmehr helped supervise the project. Mansoor Rayegani, Rama Bozorgmehr, Leila Angooti and Amir hossein Mahdi kaghazi performed the manuscript proofing.

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7.4. Conflict of interest

There is no conflict of interest

References

1. Polero P, Rebollo-Seco C, Adsuar JC, Pérez-Gómez J, Rojo-Ramos J, Manzano-Redondo F, Garcia-Gordillo MÁ, Carlos-Vivas J. Physical Activity Recommendations during COVID-19: Narrative Review. Int J Environ Res Public Health. 2020 Dec 24;18(1):65. doi: 10.3390/ijerph18010065. PMID: 33374109; PMCID: PMC7796360.
2. Siddiq M, Rathore F, Clegg D, Rasker J. Rehabilitación pulmonar en pacientes con COVID-19: una revisión del alcance de la práctica actual y su aplicación durante la pandemia. Revista turca de medicina física y rehabilitación. 2020;66(4):480-94.
3. Shirvani H. Exercise and COVID-19 as an Infectious Disease. Iran J Med Sci. 2020 Jul;45(4):311-312. doi: 10.30476/ijms.2020.86010.1566. PMID: 32801421; PMCID: PMC7395958.
4. Kurtaiş Aytür Y, Köseoğlu BF, Özyemişçi Taşkıran Ö, Ordu-Gökkaya NK, Ünsal Delialioğlu S, Sonel Tur B, Sarıkaya S, Şirzai H, Tekdemir Tiftik T, Alemdaroğlu E, Ayhan FF, Duyur Çakıt BD, Genç A, Gündoğdu İ, Güzel R, Demirbağ Karayel D, Bilir Kaya B, Öken Ö, Özdemir H, Soyupek F, Tıkız C. Pulmonary rehabilitation principles in SARS-COV-2 infection (COVID-19): A guideline for the acute and subacute rehabilitation. Turk J Phys Med Rehabil. 2020 May 12;66(2):104-120. doi: 10.5606/tftrd.2020.6444. PMID: 32760887; PMCID: PMC7401689.
5. Nopp S, Moik F, Klok FA, Gattinger D, Petrovic M, Vonbank K, Koczulla AR, Ay C, Zwick RH. Outpatient Pulmonary Rehabilitation in Patients with Long COVID Improves Exercise Capacity, Functional Status, Dyspnea, Fatigue, and Quality of Life. Respiration. 2022;101(6):593-601. doi: 10.1159/000522118. Epub 2022 Feb 24. PMID: 35203084; PMCID: PMC9059007.
6. Pauley E, Drake TM, Griffith DM, Sigfrid L, Lone NI, Harrison EM, et al. Recovery from Covid-19 critical illness: A secondary analysis of the ISARIC4C CCP-UK cohort study and the RECOVER trial. Journal of the Intensive Care Society. 2021:17511437211052226.
7. Shah R, Ali FM, Nixon SJ, Ingram JR, Salek SM, Finlay AY. Measuring the impact of COVID-19 on the quality of life of the survivors, partners and family members: a cross-sectional international online survey. BMJ Open. 2021 May 25;11(5):e047680. doi: 10.1136/bmjopen-2020-047680. PMID: 34035105; PMCID: PMC8154981.
8. Nobari H, Fashi M, Eskandari A, Villafaina S, Murillo-Garcia Á, Pérez-Gómez J. Effect of COVID-19 on Health-Related Quality of Life in Adolescents and Children: A Systematic Review. Int J Environ Res Public Health. 2021 Apr 25;18(9):4563. doi: 10.3390/ijerph18094563. PMID: 33923120; PMCID: PMC8123423.
9. Park KH, Kim AR, Yang MA, Lim SJ, Park JH. Impact of the COVID-19 pandemic on the lifestyle, mental health, and quality of life of adults in South Korea. PLoS One. 2021 Feb 26;16(2):e0247970. doi: 10.1371/journal.pone.0247970. PMID: 33635897; PMCID: PMC7909697.
10. Al Dhaheri AS, Bataineh MF, Mohamad MN, Ajab A, Al Marzouqi A, Jarrar AH, Habib-Mourad C, Abu Jamous DO, Ali HI, Al Sabbah H, Hasan H, Stojanovska L, Hashim M, Abd Elhameed OA, Shaker Obaid RR, ElFeky S, Saleh ST, Osaili TM, Cheikh Ismail L. Impact of COVID-19 on mental health and quality of life: Is there any effect? A cross-sectional study of the MENA region. PLoS One. 2021 Mar 25;16(3):e0249107. doi: 10.1371/journal.pone.0249107. PMID: 33765015; PMCID: PMC7993788.
11. Wade DT. Rehabilitation after COVID-19: an evidence-based approach. Clinical medicine. 2020;20(4):359.
12. Rayegani SM, Raeissadat SA, Fakharian A, Babaee M, Nezamabadi M, Boland Nazar NS, Angooti L. Role of rehabilitation medicine in the COVID-19 pandemic: an Iranian consensus. Eur J Phys Rehabil Med. 2021 Apr;57(2):309-310. doi: 10.23736/S1973-9087.20.06366-2. Epub 2020 Jun 19. PMID: 32558523.
13. McDermott A. Pulmonary rehabilitation for patients with COPD. Prof Nurse. 2002 May;17(9):553-6. PMID: 12025018.
14. Arazi H, Falahati A, Suzuki K. Moderate Intensity Aerobic Exercise Potential Favorable Effect Against COVID-19: The Role of Renin-Angiotensin System and Immunomodulatory Effects. Front Physiol. 2021 Nov 15;12:747200. doi: 10.3389/fphys.2021.747200. PMID: 34867452; PMCID: PMC8634264.
15. Rawal G, Yadav S, Kumar R. Post-intensive Care Syndrome: an Overview. J Transl Int Med. 2017 Jun 30;5(2):90-92. doi: 10.1515/jtim-2016-0016. PMID: 28721340; PMCID: PMC5506407.
16. Kendrick KR, Baxi SC, Smith RM. Usefulness of the modified 0-10 Borg scale in assessing the degree of dyspnea in patients with COPD and asthma. J Emerg Nurs. 2000 Jun;26(3):216-22. doi: 10.1016/s0099-1767(00)90093-x. PMID: 10839848.
17. Montazeri A, Goshtasebi A, Vahdaninia M, Gandek B.

The Short Form Health Survey (SF-36): translation and validation study of the Iranian version. Qual Life Res. 2005 Apr;14(3):875-82. doi: 10.1007/s11136-004-1014-5. PMID: 16022079.

18. Sun J, Liu J, Li H, Shang C, Li T, Ji W, Wu J, Han X, Shi Z. Pulmonary rehabilitation focusing on the regulation of respiratory movement can improve prognosis of severe patients with COVID-19. Ann Palliat Med. 2021 Apr;10(4):4262-4272. doi: 10.21037/apm-20-2014. Epub 2021 Mar 23. PMID: 33832294.
19. Gloeckl R, Leitl D, Jarosch I, Schneeberger T, Nell C, Stenzel N, Vogelmeier CF, Kenn K, Koczulla AR. Benefits of pulmonary rehabilitation in COVID-19: a prospective observational cohort study. ERJ Open Res. 2021 May 31;7(2):00108-2021. doi: 10.1183/23120541.00108-2021. PMID: 34095290; PMCID: PMC7957293.
20. F Vahdati MM. Assessing the level of market orientation at Qazvin teaching and medical hospitals: Application of the three-dimensional market analysis model. 2021;19(4):45 - 54.
21. Herridge MS, Tansey CM, Matté A, Tomlinson G, Diaz-Granados N, Cooper A, Guest CB, Mazer CD, Mehta S, Stewart TE, Kudlow P, Cook D, Slutsky AS, Cheung AM; Canadian Critical Care Trials Group. Functional disability 5 years after acute respiratory distress syndrome. N Engl J Med. 2011 Apr 7;364(14):1293-304. doi: 10.1056/NEJMoa1011802. PMID: 21470008.
22. Burnham EL, Hyzy RC, Paine R 3rd, Coley C 2nd, Kelly AM, Quint LE, Lynch D, Janssen WJ, Moss M, Standiford TJ. Chest CT features are associated with poorer quality of life in acute lung injury survivors. Crit Care Med. 2013 Feb;41(2):445-56. doi: 10.1097/CCM.0b013e31826a5062. PMID: 23263616; PMCID: PMC3671861.
23. Hanekom S, Gosselink R, Dean E, van Aswegen H, Roos R, Ambrosino N, Louw Q. The development of a clinical management algorithm for early physical activity and mobilization of critically ill patients: synthesis of evidence and expert opinion and its translation into practice. Clin Rehabil. 2011 Sep;25(9):771-87. doi: 10.1177/0269215510397677. Epub 2011 Apr 19. PMID: 21504951.
24. Spruit MA, Singh SJ, Garvey C, ZuWallack R, Nici L, Rochester C, Hill K, Holland AE, Lareau SC, Man WD, Pitta F, Sewell L, Raskin J, Bourbeau J, Crouch R, Franssen FM, Casaburi R, Vercoulen JH, Vogiatzis I, Gosselink R, Clini EM, Effing TW, Maltais F, van der Palen J, Troosters T, Janssen DJ, Collins E, Garcia-Aymerich J, Brooks D, Fahy BF, Puhan MA, Hoogendoorn M, Garrod R, Schols AM, Carlin B, Benzo R, Meek P, Morgan M, Rutten-van Mölken MP, Ries AL, Make B, Goldstein RS, Dowson CA, Brozek JL, Donner CF, Wouters EF; ATS/ERS Task Force on Pulmonary Rehabilitation. An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. Am J Respir Crit Care Med. 2013 Oct 15;188(8):e13-64. doi: 10.1164/rccm.201309-1634ST. Erratum in: Am J Respir Crit Care Med. 2014 Jun 15;189(12):1570. PMID: 24127811.
25. Alahmri F, Muaither S, Alsharhan H, Alotaibi S, Alotaibi H, Alsadi S. The effect of pulmonary rehabilitation on covid-19 patients. Phys Med Rehabil Res. 2020;5:1-4.
26. Zhou K, Dong S, Fu G, Cui S, Guo S. Massage Therapy for Pulmonary Function in Patients Recovering From Covid-19: A Protocol for Systematic Review and Meta-analysis. 2020.
27. Huang Z, Wang N, Lan Y, Li M, Chen R. Rehabilitation for the patients with severe acute respiratory syndrome in remission. Chin J Rehabil Med. 2004;10:15e7.
28. McGregor G, Sandhu H, Bruce J, Sheehan B, McWilliams D, Yeung J, Jones C, Lara B, Smith J, Ji C, Fairbrother E, Ennis S, Heine P, Alleyne S, Guck J, Padfield E, Potter R, Mason J, Lall R, Seers K, Underwood M. Rehabilitation Exercise and psycholoGical support After covid-19 InfectioN' (REGAIN): a structured summary of a study protocol for a randomised controlled trial. Trials. 2021 Jan 6;22(1):8. doi: 10.1186/s13063-020-04978-9. Erratum in: Trials. 2021 Jan 26;22(1):96. PMID: 33407804; PMCID: PMC7785779.
29. Soleimanifar M. Pulmonary Rehabilitation and Physiotherapy Management of Respiratory Conditions in Patient with COVID-19: Narrative Review. Military Caring Sciences Journal. 2020;7(1):63-72.
30. Lau HM, Ng GY, Jones AY, Lee EW, Siu EH, Hui DS. A randomised controlled trial of the effectiveness of an exercise training program in patients recovering from severe acute respiratory syndrome. Aust J Physiother. 2005;51(4):213-9. doi: 10.1016/s0004-9514(05)70002-7. PMID: 16321128; PMCID: PMC7130114.
31. Slimani M, Paravlic A, Mbarek F, Bragazzi NL, Tod D. The Relationship Between Physical Activity and Quality of Life During the Confinement Induced by COVID-19 Outbreak: A Pilot Study in Tunisia. Front Psychol. 2020 Aug 7;11:1882. doi: 10.3389/fpsyg.2020.01882. PMID: 32849104; PMCID: PMC7427614.