DOI: 10.7860/JCDR/2023/61658.17883

Original Article

Physiotherapy Section

Effect of Soft Tissue Manual Technique and Breathing Exercises on Pulmonary Function, Chest Expansion and Functional Status in Post COVID-19 Survivors: A Quasi-experimental Study

RENUKA CHANDRAKANT KHEDEKAR[1], SANTOSH P DOBHAL[2], ABHISHEK MISHRA[3]

ABSTRACT

Introduction: It is known that around one third of Coronavirus Disease-2019 (COVID-19) patients develop severe pulmonary complications and acute respiratory distress syndrome, leading to long-term impairments in Pulmonary Function Test (PFT) and physical performance. Due to deteriorating health status of the COVID-19 survivors after their recovery, rehabilitation is must.

Aim: To evaluate the effect of soft tissue manual technique and breathing exercises on PFT, chest expansion and functional status in Post COVID-19 Survivors.

Materials and Methods: This quasi-experimental study was carried out in the Department of Cardiorespiratory Physiotherapy, MGM hospital, Aurangabad, Maharashtra, India, from November 2021 to July 2022. Total 54 subjects diagnosed with COVID-19 who required oxygen therapy and had persistent respiratory symptoms for three weeks to six months after the infection, were included. All the subjects received one week of soft tissue manual techniques which included proprioceptive neuromuscular function, muscle energy technique for recruitment of diaphragm, muscles of respiration and the ribcage. Breathing exercises were inculcated at the end of the session to ensure relaxation of the subjects. Subjects were assessed for PFT, chest expansion and post COVID-19 Functional Status Scale (PCFS) pre and post-treatment. Data were analysed through Wilcoxon signed-rank Test.

Results: Amongst total 54 subjects included, 10 (18.6%) males and 44 (81.4%) females with mean age of 29.92±11.94. After one week of intervention p-value was 0.0001 for Forced Expiratory Volume (FEV1), FEV1/Forced Vital Capacity (FVC), Peak Expiratory Flow (PEF) with mean values for FEV1 at baseline was 1.91±0.51 and post-treatment was 2.45±0.34, FVC was 2.25±0.50 before the treatment whereas it was 2.73±0.36 post-treatment with p-value of 0.002, FEV1/FVC and PEF was 83.99±12.03 and 4.36±1.78 at baseline whereas, post-treatment it was 87.76±7.29 and 5.88±0.95 respectively. The p-value of 0.0001 was also similar for chest expansion. No statistically significant difference was found in post COVID-19 functional status (p-value=0.013).

Conclusion: Positive changes in the ribcage's activation and integration with its muscles were seen in all of the study variables. Therefore, it is concluded that soft tissue manipulation techniques and breathing exercise improves functional status, thoracic expansion, in post COVID-19 survivors.

Keywords: Coronavirus Disease-2019, Diaphragm facilitation, Post-isometric relaxation, Rehabilitation

INTRODUCTION

Around 20% of patients with severe COVID-19 required in-hospital management [1]. However, emerging studies show evidence of persistent cardiorespiratory symptoms, which included fatigue, dyspnoea, impaired PFT, months after hospital discharge, that impact their ability to return to home from acute hospital care [1,2].

It is known that around one third of COVID-19 patients develop severe pulmonary complications and acute respiratory distress syndrome, leading to long-term impairments in PFT and physical performance [3]. Approximately, half of the patients recovering from COVID-19 report chronic dyspnoea 2-3 months after infection [4]. At one-month follow-up, 74% of participants reported shortness of breath [5]. Carfi A et al., also assessed persistent symptoms in patients discharged from the hospital and after two months follow-up, half of the patients reported persistent fatigue, whereas dyspnoea (43%) and chest pain (22%) were also highly prevalent [5]. These findings are in line with the studies by Wong AW et al., and Garrigues E et al., both of which found nearly half of the patients complaining of breathlessness at three months after hospital discharge [6,7].

There are some case studies which shows improvement of Oxygen Saturation (SpO_2) after given therapy with soft tissue manual techniques such as Neurophysiological Facilitation of respiration (NPF), Proprioceptive Neuromuscular Facilitation (PNF) of respiration, Active Cycle of Breathing Technique (ACBT) [8,9], soft tissue manual techniques stimulates the ventilatory muscles using proprioceptive and tactile stimuli by PNF techniques which results in expansion of ribs, increased epigastric excursion, respiratory depth and rate. It also properly aligns the respiratory muscles and respiratory rhythms [10]. According to Kader M et al., during the acute phase treatment of COVID-19, 4-5 days of breathing exercises improved peripheral oxygen saturation, respiratory rate, and heart rate while reducing patients oxygen therapy requirements. The length of hospital stays halved in COVID-19 patients who received 4-5 days of breathing exercises during their acute care [11].

Due to deteriorating health status of the COVID-19 survivors after their recovery, rehabilitation is must. There are many studies which have been done to improve quality of life, physical activity and PFTs in these individuals [1,2,5,11]. But literature lacks on use of soft tissue manual techniques combined with breathing exercises to improve the PFT, thoracic mobility and the post COVID-19 functional status.

It was hypothesised that one week soft tissue manual techniques and breathing exercises will have positive effect on PFT, chest expansion, and functional status in post COVID-19 survivors. Thus, the present study was undertaken to evaluate the effect of soft tissue manual technique and breathing exercises on PFT, chest expansion and functional status in post COVID-19 survivors.

MATERIALS AND METHODS

This quasi-experimental research of pretest-post-test design was performed in the Department of Cardiorespiratory Physiotherapy, MGM hospital, Aurangabad, Maharashtra, India, from November 2021 to July 2022. Ethical Approval was obtained from Institutional Ethics Committee of MGMIOP (MGM/IOP/IEC/2021-PG/14).

Inclusion criteria: Subjects aged between 18-60 years, irrespective of their gender, who were hospitalised for COVID-19 infection, who required oxygen therapy during their hospital stay and those who had symptoms of COVID-19 such as shortness of breath, chest tightness, fatigue, cough [12] for three weeks to six months after hospital discharge were included in this study.

Exclusion criteria: Subjects were excluded if they were haemodynamically unstable, suffering with severe systemic illness, skin infections or rib fractures or had impaired cognition.

Sample size calculation: To calculate sample size formula used was ($n=Z1^2S^2/d^2$), where Z1=1.96 (alpha value), S=14.91 (Pooled SD) and d=4 (Absolute precision) [13]. Thus, calculated sample size was found to be 54.

Study Procedure

Data collection: Data regarding chest expansion, PFT test, and functional status was assessed for all the subjects, prior to intervention on day 1 and on the last day i.e., day 6.

Outcome Measures

Pulmonary Function Test (PFT):

Outpatient PFT was performed using Mini-Spir USB spirometer. Forced Expiratory Volume in the first second (FEV1), Force Vital Capacity (FVC), FEV1/FVC and Peak Expiratory Flow (PEF) was analysed. The subject was made comfortably sit on the chair, with loose clothing so that no restrictions could occur during the test. Subjects were ensuring to be completely relaxed by performing 2-3 deep breaths. Mouthpiece attached to spirometer was placed in the mouth and nose clip was placed at the nose. Subjects had to perform forceful inhalation by mouth followed by forceful prolonged exhalation for six seconds, and again deep inhalation through mouth [1].

Chest Expansion:

Chest wall expansion was measured by inch tape method to determine the range of motion of the thoracic cage. The subjects were instructed to take a deep breath and exhale while the examiner placed the inch tape around the chest at three levels i.e., axillary, nipple and xiphisternum. The difference between the inhalation and exhalation was noted. The inter-rater reliability of this measurement method is 0.99 which is close to 1 [14].

Post COVID-19 Functional Status Scale (PCFS):

This scale measured the functional state and Independence of patients after COVID-19 infection. The scale includes two items scored from 0-4 and 0-5. A high value indicates more restrictions in function and independence during daily life. Subjects were explained the use of the scale and were asked to mark their appropriate level of functional status. The inter-observer agreement of scale grade assignment was shown to be good-to-excellent with kappas of 0.75 [15].

Intervention:

The treatment protocol was carried out for six consecutive days for about 45-60 minutes.

Diaphragm Release using Post-isometric Relaxation (PIR) and Reciprocal Inhibition (RI)

Post-isometric Relaxation (PIR)- Subjects were in prone position and were instructed to breath in (close glottis or pinch nose) and resist into sub-costal area upward and lateral to lateral movement or press into lateral rib cage. This was repeated for 3-4 times. RI exhale with force [Table/Fig-1a] [16].

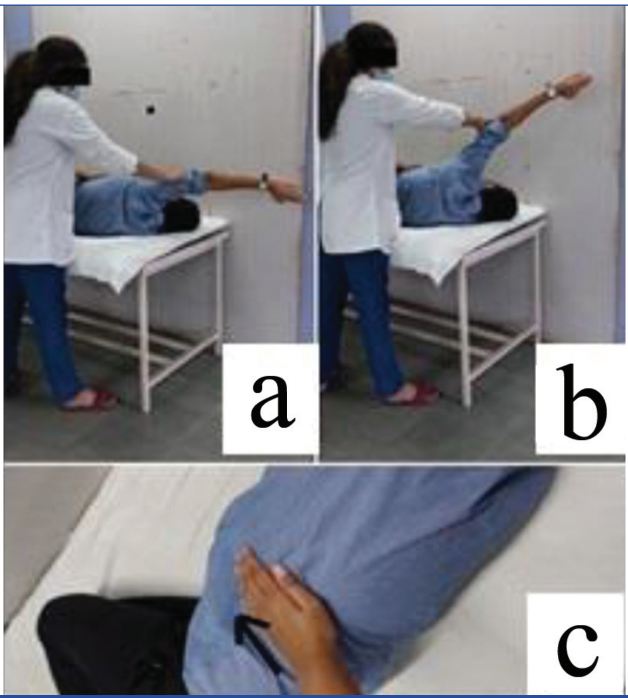
[Table/Fig-1]: a) Diaphragm release using postisometric relaxation and reciprocal inhibition; b) Muscle energy technique for lower rib cage; c) Diaphragm PNF d) Sternal pump.

Muscle energy technique for lower rib cage: Therapist placed hands on anterior surface of the lower rib cage, lifting the rib cage as the patient inhales. The patient holded their breath for five seconds after inhalation and attempted to pull their rib cage back to the table with a light force while therapist resists. Patient made to relax and therapist stretched the muscles of the rib cage by pushing in an anterior and lateral direction for five seconds. This was repeated for 3-4 times [Table/Fig-1b] [17].

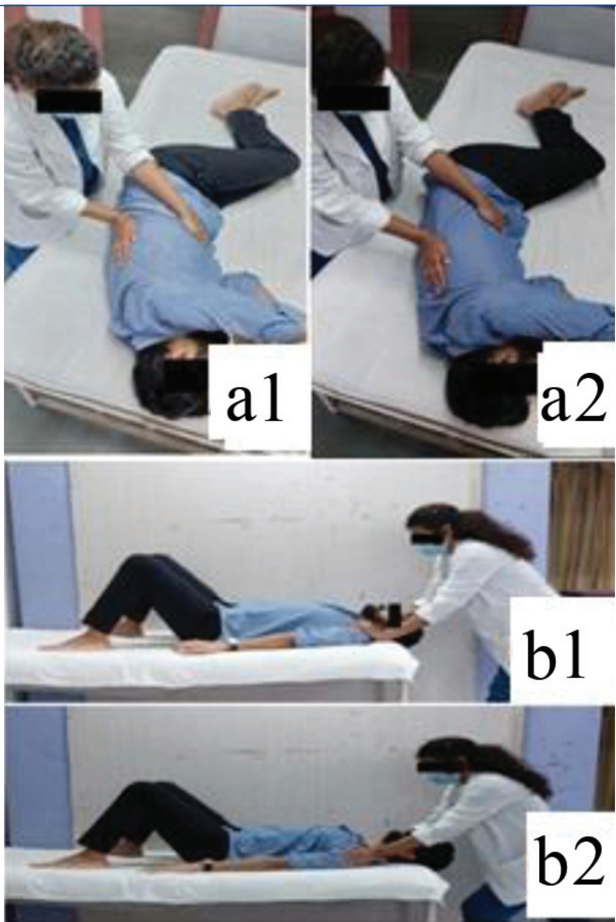
Diaphragm PNF: Therapist placed their hands on both sides of the lateral aspects of the lower rib cage and applied a slight resistance with both hands while the patient breathed into the therapist's hands for 3-5 breath cycles [Table/Fig-1c,d] [16].

PIR and stretch for lower ribcage: Patient lied on their side with the upper arm overhead. Therapist placed one hand on the lateral rib cage and the other on the patient's upper arm [Table/Fig-2a]. After an inhalation the patient was asked to hold their breath and push their arm against the therapist's hand. The therapist resisted the motion of the arm and also the expansion of the rib cage for five seconds [Table/Fig-2b]. The patient relaxed on the exhalation while the therapist stretched the muscles of the rib cage by applying gentle pressure inferiorly [Table/Fig-2c] [16].

Facilitation of diaphragm dome: Facilitation of diaphragm doming was done using upward pressure from the abdomen and downward pressure on the lower six ribs during inhalation [Table/Fig-3a1] and opposite during the exhalation [Table/Fig-3a2]. The therapist then applied sustained gentle pressure over 3-5 breath cycles [16].



[Table/Fig-2]: Postisometric relaxation and stretch for lower ribcage. a) Patient lied on the side; b) After inhalation; c) On exhalation.



[Table/Fig-3]: a) Facilitation of diaphragm dome; a1) Using upward pressure from the abdomen; a2) During exhalation; b) PIR and stretch for upper rib cage; b1) Therapist resisted the motion of the shoulders; b2) Therapist pushed the shoulders towards the patient's feet.

PIR and stretch for upper rib cage: Therapist stood at the head of the table and placed their hands on the patient's shoulders. Patient was asked to hold their breath during inhalation and to lift their shoulders towards their head against the therapist's hands with a light force. The therapist then resisted the motion of the shoulders for five seconds [Table/Fig-3b1]. The patient relaxed on exhalation while the therapist pushed the shoulders towards the patient's feet [Table/Fig-3b2].This was repeated for 3-5 times [17].

Sternal pump and sternal recoil: Participants were made to sleep in the supine position. The therapist stood behind the participant's head and placed both hands on top of each other on the participant's sternum. The participant was asked to inhale deeply. During the deep exhalation, pressure was applied with both hands in the caudal and posterior direction. The pressure was released during the next inhalation. This procedure was repeated for five times. The last two times was performed with recoil [Table/Fig-1d] [18].

Thoracic expansion exercise: Patient was asked to inhale deeply through nose and simultaneously raise both the hands up, hold the breath for few seconds and exhale through mouth and hands back to starting position, repeating for 3 times [19].

Deep Breathing exercises: Patient was made to be supine or sitting position, one hand placed on abdomen and other on chest. Patient was asked to inhale deeply focusing on his abdomen to rise more than chest and exhale through mouth for three times [19].

All the treatment techniques were performed on daily basis for six days by the therapist except thoracic expansion exercises and deep breathing exercises, which were performed by the participants under supervision.

STATISTICAL ANALYSIS

The entire data of the study was entered and cleared in Microsoft Excel before it was statistically analysed in Graphpad Prism 9.450. All the results are shown in tabular as well as graphical format to visualise the statistical significant difference more clearly. The data of qualitative characteristics was presented as n (% of cases). Mean and Standard deviation was calculated for quantitative. Normality of the data was found using Kolmogorov-Smirnov test non parametric Wilcoxon signed-rank test was applied to check the significant difference between the pre and post-test using Graph Pad. The p-value of <0.05 was considered statistically significant.

RESULTS

In the present study, the mean±Standard Deviation (SD) age of the participants was 29.92±11.94 years. Gender distribution showed that there were 44 females (81.4%) and 10 males (18.5%), whereas mean Body Mass Index (BMI) of the participants were 24.29±4.34 kg/m^2 [Table/Fig-4].

Parameters		Values
Age in years (mean±SD)		29.92±11.94
Gender	Males, n (%)	10 (18.6)
	Females, n (%)	44 (81.4)
Height in inches (mean±SD)		63.35±3.22
Weight in pounds (mean±SD)		139.02±28.44
Body mass index (kg/m^2)		24.29±4.34
Oxygen saturation (SpO^2)		98.0±1.0

[Table/Fig-4]: Baseline data for all the study subjects.

Mean values for FEV1 at baseline was 1.91±0.51 and post-treatment was 2.45±0.34 with p-value of 0.0001, FVC was 2.25±0.50 before the treatment whereas it was 2.73±0.36 post-treatment with p-value of 0.002, FEV1/FVC and PEF was 83.99±12.03 and 4.36±1.78 at baseline whereas post-treatment it was 87.76±7.29 and 5.88±0.95, respectively with p-value of 0.0001 for both which is statistically significant as p-value is <0.05, which suggests that after the intervention, there was marked improvement in the PFT of the subjects. Chest expansion which was assessed for all the three levels has also shown significant improvement after the treatment with p-value of 0.0001. No statistically significant difference was found (p-value=0.013) in post COVID-19 functional status with mean values at baseline was 2.22±0.57 whereas post-treatment was 0.11±0.31, suggestive of no improvement in the functional status of the subjects enrolled in this study [Table/Fig-5]. Therefore,

Variables	Baseline (Mean±SD)	Post-test (Mean±SD)	p-value
Thoracic expansion			
Axillary level	0.73±0.33	1.22±0.40	**0.0001**
Nipple level	0.85±0.37	1.48±0.38	**0.0001**
Xiphisternum level	1.02±0.3	1.60±0.39	**0.0001**
Pulmonary Function Test (PFT)			
FEV1	1.91±0.51	2.45±0.34	**0.0001**
FVC	2.25±0.50	2.73±0.36	**0.002**
FEV1/FVC	83.99±12.03	87.76±7.29	**0.0001**
PEF	4.36±1.78	5.88±0.95	**0.0001**
Post COVID-19 Functional Status Scale (PCFS)	2.22±0.57	0.11±0.31	**0.013**

[Table/Fig-5]: Comparison of pre and postdata for thoracic expansion, Pulmonary Function Test (PFT) and functional status scale.
FEV1: Forced expiratory volume at one second; FVC: Forced vital capacity; PEF: Peak expiratory flow; Upper: Upper chest expansion; Lower: Lower chest expansion
Statistical test used Wilcoxon signed-rank test
p-value in bold font indicates statistically significant values

the hypothesis that was taken during the start of the study was proven to be correct.

DISCUSSION

The effect of soft tissue manual techniques and breathing exercises on PFT, thoracic expansion and functional status in patients who survived from COVID-19, but were still afflicted with its symptoms were evaluated in this study. There are studies that have shown positive effects on patients with different respiratory conditions [1,2,5,11]. To the best of authors knowledge, this is the first study addressing the effects of soft tissue manual techniques and breathing exercises on PFTs, thoracic expansion and functional status in post COVID-19 patients.

The results of the present study revealed that PFT, thoracic expansion and functional status significantly improved after the treatment which included PNF and Metabolic Equivalent (MET) for diaphragm, ribcage, osteopathic manual techniques such as sternal pump-recoil, deep breathing exercises and thoracic expansion exercises. MET given to the ribcage, stimulates mechanoreceptors and send muscular-articular afferents to inhibit nociceptive afferents, as in a reflex circuit, by varying the mechanical and metabolic environment of the treated area. The technique could stimulate RI, making the activated muscles more relaxed and stretch, with gain in joint movement which is suggestive to be the reason of improvement in the present study outcomes [20].

Based on the pressure-volume relationship of the respiratory system, the higher maximum inspiratory pressure is gained when the inspiration starts from the residual volume, and vice versa. Therefore, as strong the respiratory muscles are, higher is the pulmonary volume. Thus, PFT we assume has improved because of the post-isometric relaxation technique, which required isometric contraction of upper and lower ribcage, and then a stretch, which will aid to lengthen the hypertonic muscles of the ribcage [20].

This was in contrast with the study done by Rajandekar T and Mistry H who concluded that after two days of intervention of Post-isometric relaxation and RI along with chest physiotherapy in two groups of subjects respectively, on comparing both the groups there was no statistically significant difference in both groups for chest expansion (axilla and xiphesternum), dyspnoea, respiratory rate, maximum breathing capacity [20]. Also, the results of our study are not similar with those with Anand A et al., who conducted a study on accessory inspiratory muscles energy technique effect on PFT in Chronic Obstructive Pulmonary Disease (COPD) subjects. A hold and relax stretching technique of the pectoralis major and a sham technique each for two days was given. They concluded that the hold and relax technique to the pectoralis major compared with the sham technique produced significant effects on VC, and right and left upper-limb range of motion, but there was no significant effect on chest expansion, perceived dyspnoea, or respiratory rate [21].

Altogether with lungs, chest wall is an elastic structure and follows the displacement of the lungs. Measurement of the thoracic movement is done with a measuring tape which has been used in the present study as a chest wall mobility index, from the total lung capacity to residual volume [5]. The expiratory muscles have their insertions on the lower rib cage, which reduces the chest diameter during the expiratory reserve volume, accumulating elastic energy and facilitating further expansion in the next inspiration, which increases chest wall mobility. Thus, the chest wall mobility authors assumed had increased because of the muscle energy technique which we have applied on lower ribcage. However, the results were in contrast of those with Sahin G et al., who found no significant correlation between chest wall mobility, maximum inspiratory pressure, and maximum expiratory pressure in women with fibromyalgia. They explain that this result is due to pain and muscle fatigue in those patients, which reduces respiratory muscle strength and, hence, chest wall mobility [22].

Most of the COVID-19 survivors have diverse degrees of functional restrictions ranging from negligible to severe based on PCFS. These restrictions were pretentious with age, gender, periodic influenza vaccination, smoking, duration since symptoms onset, need for oxygen or Intensive Care Unit (ICU) admittance, and finally the presence of coexisting comorbidity [23]. Authors found similar results before beginning of the trial, and have found statistically significant improvement after the treatment in the functional activity of the subjects which was assessed through PCFS. This is mostly because of the intervention which focused on the activation and integration of the soft tissues of the respiratory system, which further reduced the symptoms and had improved the functional status of the survivors.

No adverse events were reported in this study. The lack of adverse event reporting in these studies may be partially accredited to the general confusion in the literature surrounding what constitutes an adverse event in manual therapy. Adverse events in manual therapy can have a wide scope, depending on the context when it occurred. It is generally accepted that minor adverse events may occur more frequently with manual therapy interventions, and as such are expected to be transient, short term incidents that do not require further treatment [24]. Exemplar of such events include post-treatment muscular soreness, headaches, and light headedness, but none of the present study subjects had any of these. Hence, the hypothesis that was taken during start of the study was proven to be correct.

Limitation(s)

Study design was not comparing the subjects with a controlled group. Maximum subjects in this study group were mostly young population, which could have led to the positive results of the study due to faster recovery. Authors have not assessed the disease severity, by doing so, it would have added an extra feature to the result and prognosis of the intervention would have been assessed accordingly. The gold standard method for chest wall mobility evaluation optoelectronic plethysmography was not used, because this method requires highly trained personnel for both the data collection and interpretation. The present study method of measuring thoracic mobility seems to be an adequate and simpler alternative for clinical practice. Lastly, long-term follow-up of the intervention and its efficacy was not tested.

CONCLUSION(S)

Due to better improvement in all the variables of the study, authors concluded that soft tissue manual techniques and breathing exercises improves PFT, thoracic expansion and functional status in post COVID-19 survivors. Due to deteriorating health and poor quality of life in patients with post COVID-19 disease, it was must to formulate a rehabilitation protocol. The unique intervention in this study which used proprioceptive training, muscle energy techniques, and breathing exercises has proven to be beneficial in the activation and integration of the ribcage and its musculature. Further rigorous research is required to ascertain the clinical efficacy of soft tissue manual techniques for people that have survived COVID-19 infection must be undertaken. Studies implementing different methodological strategies with a larger sample can be conducted and can be combined by using gold standard method for chest wall mobility evaluation using optoelectronic plethysmography.

Acknowledgement

The authors thank all the patients and team members in the MGM Institute of Physiotherapy and MGM hospital for their general and technical support.

REFERENCES

[1] Anastasio F, Barbuto S, Scarnecchia E, Cosma P, Fugagnoli A, Rossi G, et al. Medium-term impact of COVID-19 on pulmonary function, functional capacity and quality of life. Eur Respir J [Internet]. 2021;58(3):2004015. Available from: http://dx.doi.org/10.1183/13993003.04015-2020.

[2] Curci C, Pisano F, Bonacci E, Camozzi DM, Ceravolo C, Bergonzi R, et al. Early rehabilitation in post-acute COVID-19 patients: data from an Italian COVID-19 rehabilitation unit and proposal of a treatment protocol. A cross-sectional study. Eur J Phys Rehabil Med. 2020;56(5):633-41.

[3] Motiejunaite J, Balagny P, Arnoult F, Mangin L, Bancal C, d'Ortho MP, et al. Hyperventilation: a possible explanation for long-lasting exercise intolerance in mild Covid-19 survivors?. Frontiers in Physiology. 2021;11:1856.

[4] Huang C, Huang L, Wang Y, Li X, Ren L, Gu X, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. The Lancet. 2021.

[5] Carfi A, Bernabei R, Landi F. Gemelli against COVID-19 post-acute care study group. Persistent symptoms in patients after acute COVID-19. JAMA [Internet]. 2020;324(6):603-05. Available from: http://dx.doi.org/10.1001/jama.2020.12603.

[6] Wong AW, Shah AS, Johnston JC, Carlsten C, Ryerson CJ. Patient-reported outcome measures after COVID-19: a prospective cohort study. Eur Respir J [Internet]. 2020;56(5):2003276. Available from: http://dx.doi.org/10.1183/13993003.03276-2020.

[7] Garrigues E, Janvier P, Kherabi Y, Le Bot A, Hamon A, Gouze H, et al. Post-discharge persistent symptoms and health-related quality of life after hospitalization for COVID-19. J Infect [Internet]. 2020;81(6):e4-6. Available from: http://dx.doi.org/10.1016/j.jinf.2020.08.029.

[8] Nitz J, Burke B. A study of the facilitation of respiration in myotonic dystrophy. Physiother Res Int [Internet]. 2002;7(4):228-38. Available from: http://dx.doi.org/10.1002/pri.262.

[9] Singh SP, Kumar S, Potturi G, Kumar R. Critical respiratory dysfunction and role of chest physiotherapy in Sars Cov-2 pandemic: a case series. Adv Clin Med Res. 2021;2(1):01-08.

[10] Zwoliński T, Wujtewicz M, Szamotulska J, Sinoracki T, Wąż P, Hansdorfer-Korzon R, et al. Feasibility of chest wall and diaphragm proprioceptive neuromuscular facilitation (PNF) techniques in mechanically ventilated patients. Int J Environ Res Public Health [Internet]. 2022;19(2):960. Available from: http://dx.doi.org/10.3390/ijerph19020960.

[11] Kader M, Hossain MA, Reddy V, Perera NK. Effects of short-term breathing exercises on respiratory recovery in patients with COVID-19-a quasi-experimental study. BMC Sports Science, Medicine and Rehabilitation. 2022;14(1):1-0.

[12] Spielmanns M, Pekacka-Egli AM, Schoendorf S, Windisch W, Hermann M. Effects of a comprehensive pulmonary rehabilitation in severe post-COVID-19 patients. International journal of environmental research and public health. 2021;18(5):2695.

[13] Stepnik J, Kędra A, Czaprowski D. Short-term effect of osteopathic manual techniques (OMT) on respiratory function in healthy individuals. PLoS One [Internet]. 2020;15(6):e0235308. Available from: http://dx.doi.org/10.1371/journal.pone.0235308

[14] Bockenhauer SE, Chen H, Julliard KN, Weedon J. Measuring thoracic excursion: reliability of the cloth tape measure technique. J Am Osteopath Assoc. 2007;107(5):191-96.

[15] Klok FA, Boon GJAM, Barco S, Endres M, Geelhoed JJM, Knauss S, et al. The post-COVID-19 functional status scale: a tool to measure functional status over time after COVID-19. Eur Respir J [Internet]. 2020;56(1):2001494. Available from: http://dx.doi.org/10.1183/13993003.01494-2020.

[16] Courtney R. The functions of breathing and its dysfunctions and their relationship to breathing therapy. Int J Osteopath Med [Internet]. 2009;12(3):78-85. Available from: http://dx.doi.org/10.1016/j.ijosm.2009.04.002.

[17] Nd LC, editor. Muscle Energy Techniques: with access to www. Chaitow muscle energy techniques. com. Elsevier Health Sciences; 2013.

[18] Naralia TW, Permatasari H. The effectiveness of breathing exercises for post Covid-19 patients during rehabilitation: a literature review. STRADA Jurnal Ilmiah Kesehatan. 2021;10:844-50.

[19] Goodridge JP. Muscle energy technique: Definition, explanation, methods of procedure. J Am Osteopath Assoc. [Internet]. 1981;81(12):67-74. Available from: http://dx.doi.org/10.1515/jom-1981-811211

[20] Rajandekar T, Mistry H. Comparison between post isometric relaxation and reciprocal inhibition techniques of muscle energy techniques on respiratory function in patients with chronic obstructive airway diseases. International Journal of Current research. 2018;10(11):75505-27.

[21] Anand A, Narwal R, Sindhwani G. Accessory inspiratory muscles energy technique effect on pulmonary function in COPD subjects. Indian J Physiother Occup Ther [Internet]. 2013;7(3):192. Available from: http://dx.doi.org/10.5958/j.0973-5674.7.3.091.

[22] Sahin G, Ulubaş B, Calikoğlu M, Bolgen Cime O, Erdoğan C. Is chest expansion a determinant of pulmonary muscle strength in primary fibromyalgia? Joint Bone Spine [Internet]. 2004;71(2):140-43. Available from: http://dx.doi.org/10.1016/S1297-319X(03)00055-1.

[23] Hussein AA, Saad M, Zayan HE, Abdelsayed M, Moustafa M, Ezzat AR, et al. Post-COVID-19 functional status: Relation to age, smoking, hospitalization, and previous comorbidities. Annals of Thoracic Medicine. 2021;16(3).

[24] Carnes D, Mars TS, Mullinger B, Froud R, Underwood M. Adverse events and manual therapy: a systematic review. Man Ther [Internet]. 2010;15(4):355-63. Available from: http://dx.doi.org/10.1016/j.math.2009.12.006.

PARTICULARS OF CONTRIBUTORS:

1. Student (Postgraduate), Department of Cardiorespiratory Physiotherapy, MGM Institute of Physiotherapy, Aurangabad, Maharashtra, India.
2. Associate Professor, Department of Cardiorespiratory Physiotherapy, MGM Institute of Physiotherapy, Aurangabad, Maharashtra, India.
3. Assistant Professor, Department of Cardiorespiratory Physiotherapy, MGM Institute of Physiotherapy, Aurangabad, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Renuka Chandrakant Khedekar,
N7, CIDCO Plot No. 3, Sector C/3, Aurangabad, Maharashtra, India.
E-mail: renu.khedekar@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Dec 08, 2022
- Manual Googling: Feb 14, 2023
- iThenticate Software: Mar 24, 2023 (16%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Dec 02, 2022**
Date of Peer Review: **Jan 06, 2023**
Date of Acceptance: **Mar 31, 2023**
Date of Publishing: **May 01, 2023**