Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 30s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Effectiveness Of Structured Strengthening Protocol Of Thoracic Opener Muscles In Chronic Smokers

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Cite this paper as: Sakshi Sachin Kadam, Dr. Mandar Malawade, (2025) Effectiveness Of Structured Strengthening Protocol Of Thoracic Opener Muscles In Chronic Smokers. *Journal of Neonatal Surgery*, 14 (30s), 770-773.

ABSTRACT

Background: Chronic smoking impairs pulmonary function by altering respiratory mechanics and reducing thoracic mobility due to postural changes and muscular fatigue. Strengthening thoracic opener muscles may counteract these effects by enhancing chest wall mobility and respiratory efficiency.

Objective: To evaluate the effect of an 8-week structured strengthening protocol targeting thoracic opener muscles on pulmonary function in chronic smokers.

Methods: Twenty chronic smokers aged 30–50 years participated in this experimental study. Participants underwent a thrice-weekly, 45-minute structured exercise program focusing on thoracic opener muscles. Pulmonary function was assessed using Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 Second (FEV_1), FEV_1/FVC ratio, and Peak Expiratory Flow Rate (PEFR) before and after the intervention.

Results: Statistically significant improvements were observed in all outcome measures post-intervention: FEV_1 increased from 2.10 ± 0.35 L to 2.45 ± 0.38 L ($p = 0.0002$), FVC from 2.90 ± 0.42 L to 3.35 ± 0.40 L ($p = 0.0001$), FEV_1/FVC ratio from 72.4 ± 5.8% to 75.6 ± 6.0% ($p = 0.004$), and PEFR from 315 ± 40 L/min to 370 ± 45 L/min ($p < 0.0001$).

Conclusion: The structured thoracic opener muscle strengthening protocol significantly enhanced pulmonary function in chronic smokers. These findings support the inclusion of targeted physiotherapy in pulmonary rehabilitation strategies to mitigate smoking-related respiratory decline.

1. INTRODUCTION

Thoracic opening muscles, which are mostly made up of the erector spinae , middle and lower trapezius, and rhomboids, are essential for preserving an upright thoracic position and promoting the best possible chest expansion while breathing. These muscles assist effective pulmonary function by counteracting the anterior pull of the pectoral muscles and making a substantial contribution to the thoracic cage opening. However, smoking for an extended period of time has a number of negative impacts on the respiratory and musculoskeletal systems. Chronic inflammation is caused by tobacco smoke inhalation over time, Muscle exhaustion and decreased oxygen delivery lead to postural changes including rounded shoulders and elevated thoracic kyphosis. Over time, these postural alterations weaken the thoracic opening muscles, impairing thoracic mobility and limiting lung expansion. Furthermore, smokers are more likely to experience respiratory muscle fatigue and changed breathing biomechanics, which further reduces pulmonary efficiency. [1]

It is well established that smoking cigarettes is the main factor causing pulmonary function impairment. Cancers, chronic obstructive pulmonary illnesses (COPD), and cardiovascular and cerebrovascular disorders are all known to be caused by it. Forcible expiratory volume in one second (FEV1), forced vital capacity (FVC), FEV1/FVC, and diffusing capacity for carbon monoxide (DLCo) are all thought to be negatively impacted by smoking, whether active or passive, while also increasing the value of forced residual capacity. Sedentary lifestyles and smoking have been linked to poorer FEV1, FVC, and FEV1/FVC ratios in both men and women, as well as worse MTT scores. Thoracic mobility, musculoskeletal integrity, and lung health are all necessary for effective lung function. Restricting the thoracic cage can result in ineffective ventilation because it is essential for deep breathing. In persistent smokers, strengthening the thoracic opener muscles can help improve ribcage expansion, improve oxygen intake, and lessen breathing effort. [2]

Muscular exercise has been shown to enhance O2 intake, diffusion rate, and breathing depth and rate, all of which improve FVC. Additionally, it has been demonstrated that among active smokers, moderate-to-high levels of regular physical exercise are linked to a lower risk of COPD and a deterioration in lung function. According to the most recent guidelines on pulmonary rehabilitation (PR), physical therapy programs tailored to individuals with COPD should incorporate exercise training aimed at the upper extremity (UE) muscles. A known risk factor for respiratory dysfunction is long-term smoking, which weakens the respiratory muscles, reduces thoracic movement, and reduces lung capacity. Smoking habitually causes postural abnormalities over time, such as reduced chest expansion and increased thoracic kyphosis, which worsen pulmonary function. Enhancing lung function, reducing respiratory strain, and improving chest wall mechanics can all be achieved by strengthening the thoracic opener muscles, which include the pectoralis minor, serratus anterior, and intercostals . Research particularly examining the efficacy of structured strengthening protocols for thoracic opening muscles is still lacking, despite the fact that upper-body resistance workouts and inspiratory muscular training (IMT) have been investigated in populations with smoking-induced pulmonary restrictions.[3] The purpose of the present research is to investigate how these regimens affect the respiratory efficiency, posture, and pulmonary function of long-term smokers. [4] Structured strengthening programs may provide a non-pharmacological means of reducing some of the negative effects of long-term smoking on respiratory health by treating muscle imbalances and thoracic tightness. There is little data on the efficacy of certain musculoskeletal therapies, especially systematic strengthening regimes for thoracic openers, despite the well-established consequences of smoking on respiratory mechanics. By assessing how well such a procedure improves thoracic mobility, respiratory function, and general lung health in chronic smokers, this study aims to close this gap. This study aims to assess the effectiveness of an 8-week structured strengthening protocol targeting thoracic opener muscles in chronic smokers and its impact on pulmonary function, as measured by Pulmonary Function Tests (PFT) and Peak Flow Rate (PFR). [5]

2. METHODS AND MATERIALS

An experimental study was conducted at Krishna Vishwavidyapeeth after receiving approval from the institutional review board and ethics committee to look into the therapeutic advantages of combining thoracic opener muscle strengthening exercises for chronic smokers.

PARTICIPANTS

Twenty people between the ages of 30 and 50 who had smoked for more than five years were the subjects of this experimental study. The following inclusion and exclusion criteria were used in the recruitment of participants: Criteria for Inclusion: Those who have been smokers for at least five years , No history of severe diseases or recent respiratory infections, No long-term respiratory diseases such as asthma or COPD have been identified, Willingness to engage in an intervention program lasting eight weeks , Requirements for exclusion: Participants in any other respiratory rehabilitation programs; those with severe cardiovascular problems; and people with musculoskeletal illnesses that impair thoracic mobility. The thoracic opener muscles were the focus of an 8-week organized strengthening program for the participants. Three times a week, 45-minute sessions of exercise were conducted.

Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures. The goal of the study was explained to the participants, and they were informed about the procedure. After reading the volunteer form, which covered the study's specifics, risks, rewards, confidentiality, and participant rights, the participant gave their informed consent. The rights and welfare of the participants were given top priority in the design, procedures, and confidentiality measures of the study, which closely followed ethical guidelines. The participants were told about the technique and the purpose of the study.

3. OUTCOME MEASURES

Pulmonary function test (PFT)-

Forced Vital Capacity (FVC): Indicates lung capacity and thoracic muscle efficiency by measuring the total amount of air breathed during a maximal forced expiration.

Airway blockage or restriction is indicated by the Forced Expiratory Volume in 1 Second (FEV1), which measures the amount of air exhaled in the first second of a forced expiration. The unit is liters (L). Spirometry is the method. FEV1/FVC Ratio: To identify obstructive tendencies typical of chronic smokers, it measures the percentage of essential capacity expelled in the first second. Percentage (%) is the unit. Approach: Based on spirometry data.

Peak Flow Rate (PFR)-

Peak Expiratory Flow (PEF): Evaluates the maximal expiratory velocity, which reflects airway patency and the strength and coordination of the thoracic muscles. Unit: L/min, or liters per minute Peak flow meter as the method. Goal: Shows gains in airway clearance and expiratory muscular power, which the strengthening regimen may amplify.

4. RESULT

Outcome measure	Pre	Post	P - value
FEV_1 (L)	2.10 ± 0.35	2.45 ± 0.38	0.0002
FVC (L)	2.90 ± 0.42	3.35 ± 0.40	0.0001
FEV_1/FVC (%)	72.4 ± 5.8	75.6 ± 6.0	0.004
PEFR (L/min)	315 ± 40	370 ± 45	<0.0001

Twenty participants in all finished the intervention procedure. Analyzing the pulmonary function test (PFT) results before and after treatment showed statistically significant gains in every outcome that was examined.

With a mean increase of +0.35 L ($p = 0.0002$) from 2.10 ± 0.35 L before treatment to 2.45 ± 0.38 L after, the Forced Expiratory Volume in 1 Second (FEV_1) indicated enhanced expiratory capacity. The FVC also increased from 2.90 ± 0.42 L to 3.35 ± 0.40 L, with a mean difference of +0.45 L ($p = 0.0001$), indicating improved ventilatory capacity and lung volume.

An important metric for assessing airflow limitation, the FEV_1/FVC ratio, increased by a mean of 3.2% ($p = 0.004$), from 72.4 ± 5.8% to 75.6 ± 6.0%. This improvement suggests a decrease in airway restriction patterns, which are frequently observed in long-term smokers. Additionally, the mean improvement of +55 L/min was shown by the Peak Expiratory Flow Rate (PEFR), which increased significantly from a pre-treatment mean of 315 ± 40 L/min to 370 ± 45 L/min ($p < 0.0001$). This alteration signifies a significant improvement in airway patency and expiratory force. All of these results point to a beneficial and statistically significant effect of the structured thoracic opening muscle strengthening program on chronic smokers' pulmonary function.

5. DISCUSSION

This study investigated the impact on pulmonary function in chronic smokers of a targeted strengthening program aimed at thoracic opening muscles. The intervention effectively improved thoracic mobility and respiratory mechanics, as seen by the results, which showed a statistically significant increase across all evaluated outcomes.

FEV_1 showed a significant improvement, rising from 2.10 ± 0.35 L to 2.45 ± 0.38 L ($p = 0.0002$), indicating better expiratory flow. Likewise, FVC increased from 2.90 ± 0.42 L to 3.35 ± 0.40 L ($p = 0.0001$), indicating greater respiratory muscle function and lung capacity. Better airflow dynamics were indicated by a 3.2% rise ($p = 0.004$) in the FEV_1/FVC ratio, a crucial sign of airway blockage. PEFR increased significantly from 315 ± 40 L/min to 370 ± 45 L/min ($p < 0.0001$), indicating thoracic extension and greater large airway patency.

These outcomes are consistent with previous research by Sharma et al. (2019), who found that thoracic mobility exercises improved pulmonary function in populations with impaired respiratory function. Furthermore, Lee and Kim (2021) discovered that in smokers and older adults, thoracic mobilization in conjunction with diaphragmatic breathing considerably increased peak expiratory flow and lung compliance.

Several elements of the procedure, such as diaphragmatic breathing with resistance, thoracic extension on foam rollers, and serratus anterior activation, are responsible for the noted improvements. The functional improvements following therapy were probably facilitated by these activities, which also enhanced diaphragmatic excursion, auxiliary muscle recruitment, and chest wall compliance. [6]

Normal people who received high frequency inspiratory muscle training showed notable improvements in their breathing capacity, total breathing capacity, inspiratory muscular strength, and inspiratory endurance, according to a study by Enright et al. Normal people who had received breathing training showed significant variations between their inspiratory and expiratory volumes in a research by Townsend18. [7]

The significance of thoracic-focused physical therapy regimens in regaining and enhancing respiratory function is underscored by these findings taken together, particularly in individuals whose thoracic mobility has been physically or functionally impaired as a result of long-term smoking.

6. CONCLUSION

The structured thoracic opener muscle strengthening protocol significantly improved pulmonary function in chronic smokers, as evidenced by increased FEV_1, FVC, FEV_1/FVC ratio, and PEFR values. This highlights the effectiveness of targeted physiotherapy in enhancing respiratory efficiency and lung health in this population. These findings suggest that targeted physiotherapy not only improves chest wall mobility and respiratory muscle performance but also contributes to better overall

lung function. Given the significant increases observed in all parameters ($p < 0.005$), the protocol may serve as a valuable adjunct to conventional management strategies for chronic smokers, potentially mitigating the adverse respiratory effects associated with smoking.

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