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Original Article

Short-term effects of respiratory physiotherapy training on pulmonary function test parameters

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ABSTRACT

Background: In this study, we aimed to determine the effect of preoperative respiratory exercise training and practice on spirometric parameters, which are among the most critical factors evaluated prior to surgery.

Materials and Methods: Fifth-year medical students consisting of healthy individuals were included in the study. The participants were divided into a study group and a control group. The study group received respiratory physiotherapy training and was instructed to perform the exercises for four days. Pulmonary function tests were administered to both groups on the first and fifth days.

Results: A total of 118 healthy individuals with a mean age of 24.27 ± 1.18 years were included in the study. Of these, 66 participants constituted the study group and 52 the control group. In the study group, the second measurement of forced vital capacity (FVC) was significantly lower than the first measurement ($p < 0.001$). In the control group, no statistically significant difference was observed between pre- and post-measurements. The FVC% predicted was also significantly lower in the second measurement compared to the first in the study group ($p < 0.001$). Furthermore, the second FVC measurement in the study group was significantly lower than that of the control group ($p = 0.045$). The change in forced expiratory volume in one second (FEV_1) differed significantly between the study and control groups ($p = 0.018$). While a decrease in FEV_1 was observed in the study group, an increase was noted in the control group.

Conclusions: We suggest that individualized physiotherapy protocols and targeted interventions are required to accurately determine the true impact of respiratory physiotherapy in preoperative settings.

Keywords: enhanced recovery after surgery (ERAS), thoracic surgery, pulmonary rehabilitation, spirometry

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Introduction

Lung cancer is the third most commonly diagnosed malignancy and remains one of the leading causes of cancer-related mortality worldwide. In non-small cell lung cancer (NSCLC), which constitutes the majority of lung cancer cases, lobectomy is considered the gold standard treatment, particularly in early-stage disease. In selected cases and in patients with limited pulmonary reserve, segmentectomy or wedge resection may also be performed [1]. Preoperative risk assessment in resectable patients heavily relies on cardiopulmonary functional evaluation. A significant proportion of patients diagnosed with lung cancer, particularly males, also have concomitant chronic obstructive pulmonary disease (COPD). Approximately 37% of patients deemed resectable are ultimately considered inoperable due to insufficient pulmonary functional capacity [1-3].

Pulmonary resection surgery may lead to a reduction in lung volumes and respiratory muscle strength, potentially resulting in postoperative respiratory failure. In recent years, video-assisted thoracoscopic surgery (VATS) has become increasingly widespread, and due to its minimally invasive nature with smaller incisions, it reduces respiratory muscle impairment and significantly lowers postoperative morbidity and mortality rates. Nevertheless, reduced preoperative pulmonary function remains a major factor associated with increased postoperative morbidity and mortality [1,2].

In recent years, considerable emphasis has been placed on the development and systematic implementation of perioperative care protocols aimed at reducing postoperative morbidity and mortality. Within this context, Enhanced Recovery After Surgery (ERAS) protocols have been shown to decrease hospital length of stay and postoperative complications. One of the key objectives of ERAS protocols is to improve postoperative pulmonary capacity in the remaining lung and to prevent respiratory failure [4].

In the present study, we aimed to evaluate the impact of short-term preoperative respiratory physiotherapy training on baseline spirometric parameters in healthy individuals to assess its potential role in optimizing preoperative pulmonary capacity.

Materials and Methods

Fifth-year medical students attending the thoracic surgery clerkship were prospectively enrolled in the study on a voluntary basis. All participants underwent pulmonary function testing on the first day. Subsequently, participants were randomly assigned to either the study group or the control group. The internship groups consisted of 25 participants each, and allocation was performed randomly using a lottery-based method. According to the results of the randomization process, the internship groups were assigned to either the control group or the study group. Participants in the control group received no training or intervention, and pulmonary function testing was repeated on day 5. In the study group, following the initial pulmonary function test on day 1, participants received respiratory exercise training from a respiratory physiotherapist and were instructed to perform these exercises daily. After four days of presumed adherence to the exercise program, pulmonary function testing was repeated on day 5. Height and weight of all participants were measured, and body mass index (BMI) was calculated. Participant characteristics and all obtained data were recorded and analyzed statistically. Participants were excluded if they had a known chronic disease, a history of thoracic surgery or thoracic trauma, a history of inflammatory airway disease such as asthma, an upper respiratory tract infection within one week prior to or during the five-day study period, or if they declined participation or failed to complete either of the pulmonary function tests.

This study was conducted with the approval of Non-Interventional Clinical Research Ethics Committee of Izmir Katip Çelebi University (Approval No. 2023/597).

Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as number (n), percentage (%), mean ± standard deviation (mean ± SD), median (M), and minimum (min)–maximum (max) values. Comparisons of measurements between groups were performed using Mixed Design ANOVA. Bonferroni correction was applied for pairwise comparisons of main effects. Differences between pre- and post-measurements were calculated and compared between groups. Variables were analyzed using the independent samples t-test when parametric assumptions were met, and the Mann–Whitney U test when these assumptions were not satisfied. After categorization of FEV_1 and FVC values, pre- and post-intervention differences were evaluated using the McNemar test. A p-value of <0.05 was considered statistically significant.

Results

A total of 118 healthy individuals (53 females and 65 males) with a mean age of 24.27 ± 1.18 (range, 23-27) years were included in the study. Of these, 66 participants were assigned to the study group and 52 to the control group. The mean height, weight, and body mass index (BMI) of the participants were 173.78 ± 9.65 cm, 69 ± 14.83 kg, and 22.78 ± 3.37 kg/m², respectively. No significant differences were observed between the groups in terms of baseline demographic characteristics.

Pulmonary function test parameters, including FEV_1, FVC, FEV_1/FVC, peak expiratory flow (PEF), maximal expiratory flow at 25% (MEF25), 50% (MEF50), and 75% (MEF75), were compared before and after training and exercise within each group. The results are presented in Table 1. Accordingly, no statistically significant differences were observed in FEV_1, FEV_1/FVC, MEF50, and MMEF values between pre- and post-measurements in either group. MEF25 decreased significantly from pre- to post-measurement in the study group (F = 5.764; p = 0.018), whereas no statistically significant change was observed in the control group (F = 0.015; p = 0.902).

Table 1. Comparison of values within and between groups.

	Groups		Test Statistics		
	Study Group	Control Group	F	p	η2
FEV1					
Pre	3.74±0.92	3.91±1.03	0.927	0.338	0.008
Post	3.67±0.87	3.98±1.02	3.192	0.077	0.027
Test Statistics	**F=2.106; p=0.149; η2=0.018**	F=1.858; p=0.175; η2=0.016			
FEV1 (% predicted)					
Pre	89.77±12.56	93.01±15.71	1.556	0.215	0.013
Post	88.12±11.31	93.65±14.38	5.470	0.021	0.045
Test Statistics	F=1.840; p=0.178; η2=0.016	F=0.214; p=0.645; η2=0.002			
FVC					
Pre	4.62±1.05	4.77±1.03	0.587	0.445	0.005
Post	4.46±0.97	4.78±1.09	2.807	0.097	0.024
Test Statistics	F=21.117; p<0.001; η2=0.154	F=0.045; p=0.833; η2=0.001			
FVC (% predicted)					
Pre	94.31±10.13	96.30±11.66	0.981	0.324	0.008
Post	91.22±10.10	95.15±10.89	**4.097**	**0.045**	**0.034**
Test Statistics	F=18.414; p<0.001; η2=0.137	F=2.022; p=0.158; η2=0.017			
FEV1/FVC					
Pre	80.95±8.42	81.89±9.97	0.311	0.578	0.003
Post	82.24±7.48	83.20±8.05	0.444	0.506	0.004
Test Statistics	F=2.076; p=0.152; η2=0.018	F=1.663; p=0.200; η2=0.014			
PEF					
Pre	5.73±2.08	6.80±2.65	**6.047**	**0.015**	**0.050**
Post	6.18±2.06	7.21±2.59	**5.796**	**0.018**	**0.048**
Test Statistics	**F=6.083; p=0.015; η2=0.050**	**F=3.990; p=0.048; η2=0.033**			
MEF25					
Pre	2.25±0.74	2.40±0.88	0.942	0.334	0.008
Post	2.11±0.72	2.39±0.89	3.337	0.070	0.028
Test Statistics	**F=5.764; p=0.018; η2=0.047**	F=0.015; p=0.902; η2=0.001			
MEF50					
Pre	4.31±1.43	4.72±1.69	1.968	0.163	0.017
Post	4.27±1.25	4.75±1.56	3.350	0.070	0.028
Test Statistics	F=0.110; p=0.740; η2=0.001	F=0.055; p=0.812; η2=0.001			
MEF75					
Pre	5.48±1.99	6.36±2.49	**4.518**	**0.036**	**0.037**
Post	5.82±1.96	6.57±2.30	3.656	0.058	0.031
Test Statistics	F=3.700; p=0.057; η2=0.031	F=1.163; p=0.283; η2=0.010			
MMEF					
Pre	3.87±1.23	4.32±1.56	3.012	0.085	0.025
Post	3.84±1.08	4.25±1.36	3.396	0.068	0.028
Test Statistics	F=0.149; p=0.700; η2=0.001	F=0.384; p=0.536; η2=0.003			

F: Mixed Design ANOVA. Effect Size (η2). Descriptive statistics are given as mean ± standard deviation. Sections highlighted in bold are statistically significant (p<0.05).

In the study group, the second measurement of FVC was significantly lower than the first measurement ($p < 0.001$), whereas no significant difference was observed in the control group. Similarly, the percentage of FVC in the study group was significantly lower in the second measurement compared to the first ($p < 0.001$). Furthermore, the second FVC measurement in the study group was significantly lower than that of the control group ($p = 0.045$). For MEF75, the initial measurement in the study group was significantly lower than that in the control group ($p = 0.036$). The PEF value in the study group was significantly higher in the second measurement compared to the first ($p = 0.015$). A similar increase was observed in the control group ($p = 0.048$). Both the first and second PEF measurements in the study group were significantly lower than those in the control group ($p = 0.015$ and $p = 0.018$, respectively).

Intergroup comparisons of the differences between pre- and post-training measurements are presented in Table 2. The change in FEV_1 differed significantly between the study and control groups ($p = 0.018$), with a decrease observed in the study group and an increase in the control group. The percentage change in FEV_1 was statistically similar between the groups. The change in FVC also differed significantly between the groups ($p = 0.002$), with a decrease in the study group and an increase in the control group. All remaining variables showed no statistically significant differences between the study and control groups.

In addition, when FEV_1 and FVC values were categorized based on whether they were below or above 80% of the predicted values, no statistically significant differences were observed between the groups in either measurement period.

Table 2. Comparison of variable difference values by groups.

	Groups		Test Statistics	
	Study Group	Control Group	Test value	p value
FEV1	0.06±0.35 0.11 (0.42)	-0.07±0.40 -0.08 (0.36)	z=2.374	0.018
FEV1 (% predicted)	1.65±8.99 3 (10.5)	-0.63±10.92 1 (10.75)	z=1.362	0.173
FVC	0.16±0.28 0.20 (0.48)	-0.01±0.28 0.01 (0.39)	t=3.209	0.002
FVC (% predicted)	3.09±6.25 4 (10)	1.15±5.28 2 (7.75)	z=1.773	0.076
FEV1/FVC	-1.29±5.91 -0.40 (5.60)	-1.30±8.77 -0.15 (5.10)	z=0.298	0.766
PEF	-0.44±1.40 -0.37 (1.79)	-0.40±1.57 -0.37 (1.53)	t=0.143	0.886
MEF25	0.13±0.38 0.14 (0.47)	0.01±0.54 -0.02 (0.49)	z=1.827	0.068
MEF50	0.03±0.89 -0.01 (1.17)	-0.03±1.02 0.01 (0.87)	z=0.035	0.972
MEF75	-0.34±1.34 -0.32 (1.69)	-0.21±1.57 -0.25 (1.77)	t=0.470	0.639
MMEF	0.03±0.65 0.08 (0.71)	0.06±0.91 0.01 (1.04)	z=0.393	0.694

Descriptive values are given as mean ± standard deviation and median (interquartile range). z: Mann Whitney U test, t: Independent two-sample t-test. Differences (Δ) were calculated as pre-intervention minus post-intervention values (Pre – Post); therefore, positive values indicate a decrease, and negative values indicate an increase from pre- to post-intervention.

Discussion

The primary aims of respiratory physiotherapy are to increase lung volumes, facilitate secretion clearance, and enhance respiratory muscle strength, thereby improving overall respiratory capacity. Previous studies have demonstrated that preoperative respiratory muscle training can lead to improvements in spirometric parameters, particularly FEV_1 and FVC. However, the magnitude of these effects varies depending on the duration of the intervention and the target population, with exercise programs longer than six weeks reported to yield more substantial benefits [5-7]. Additionally, supervised and device-assisted respiratory exercises have been shown to be more effective than unsupervised home-based programs [7]. In the present study, the lack of expected improvement in FEV_1 and FVC values may be attributed to several factors, including the inclusion of healthy individuals, the short duration of the exercise program (four days), and the possibility of suboptimal adherence due to the study population consisting of students.

Studies conducted in patients with chronic obstructive pulmonary disease (COPD) have demonstrated that respiratory muscle training has significant effects on respiratory capacity and dyspnea, while its impact on FEV_1 and FVC remains limited. Similarly, in patients undergoing thoracic surgery, preoperative respiratory physiotherapy has been shown to improve functional lung capacity and reduce postoperative complications; however, its short-term effects on spirometric parameters appear to be minimal [8-10]. While patients with impaired pulmonary reserve may exhibit a more pronounced response to such interventions, studies involving healthy individuals generally do not demonstrate significant improvements. This phenomenon may be explained by a ceiling effect, as healthy individuals are already operating near their maximal pulmonary capacity [8,10,11]. Consistent with these findings, the absence of expected spirometric improvements in our study may be attributed to the inclusion of a healthy study population.

In our study, a significant increase in PEF values was observed in both the study and control groups. This finding is likely attributable to a learning effect. The learning effect in spirometry refers to improved patient performance with repeated testing, particularly in effort-dependent parameters, as a result of increased familiarity and compliance with the procedure. Current guidelines published by the European Respiratory Society (ERS) and the American Thoracic Society (ATS) recommend repeated respiratory maneuvers to ensure reliable spirometry measurements [12].

In recent years, with the increasing implementation of Enhanced Recovery After Surgery (ERAS) protocols, the importance of respiratory physiotherapy has become more evident. Respiratory physiotherapy integrated within ERAS protocols has been shown to reduce postoperative pulmonary complications and shorten hospital length of stay [13].

In this study, we aimed to evaluate the effects of short-term respiratory physiotherapy training in healthy individuals. In line with the existing literature, we observed a decrease rather than an improvement in FEV_1 and FVC values, likely due to factors such as the inclusion of healthy participants, the short duration of the intervention, and the characteristics of the selected population. The observed increase in PEF values was consistent with the literature and can be attributed to repeated testing and the associated learning effect.

Limitations of the study

The greatest limitation of our study stemmed from the characteristics of the study population. Because the study was conducted on young and healthy individuals, the intended objectives of the research could not be fully achieved, thereby limiting the overall clinical applicability and guiding value of the findings. Another important limitation was the inability to monitor the extent to which participants adhered to and regularly performed the prescribed breathing exercises for which they had received training.

In conclusion, our findings suggest that short-term respiratory physiotherapy interventions in healthy individuals do not significantly improve spirometric parameters, in accordance with the existing literature. To accurately evaluate the true impact of respiratory physiotherapy, future studies should focus on high-risk patient populations with limited pulmonary reserve and employ longer-duration, individualized, and targeted physiotherapy programs.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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Ethics approval

This study was conducted with the approval of the İzmir Katip Çelebi University Non-Interventional Clinical Research Ethics Committee (Approval No. 2023/597).

Authors' contribution

MU: Conceptualization, methodology, data curation, project administration, writing-original draft, formal analysis, validation. BCS: data curation, resources, investigation, formal analysis. OB: data curation, resources. MK: Writing, review, editing, visualization, supervision. SST: data curation, resources. KIT: Conceptualization, data curation, resources. SS: data curation, resources.

References

1. Zhong J, Trinh I, Raju S, Hsu M. Pulmonary rehabilitation in patients with operable non-small cell lung cancer. J Clin Med 2025; 14: 1-17.
2. Sanchez-Lorente D, Navarro-Ripoll R, Guzman R, Moises J, Gimeno E, Boada M et al. Prehabilitation in thoracic surgery. J Thorac Dis 2018; 10: 2593-600.
3. Baser S, Shannon VR, Eapen GA, Jimenez CA, Onn A, Keus L et al. Pulmonary dysfunction as a major cause of inoperability among patients with non-small-cell lung cancer. Clin Lung Cancer 2006; 7: 344-9.
4. Batchelor TJP, Rasburn NJ, Abdelnour-Berchtold E, Brunelli A, Cerfolio RJ, Gonzalez M et al. Guidelines for enhanced recovery after lung surgery: recommendations of the Enhanced Recovery After Surgery (ERAS) Society and the European Society of Thoracic Surgeons (ESTS) Eur J Cardiothorac Surg 2019; 55: 91-115.

5. Weiner P, Azgad Y, Ganam R, Weiner M. Inspiratory muscle training in patients with bronchial asthma. Chest 1992; 102: 1357-61.

6. Hulzebos EHJ, Helders PJM, Favié NJ, De Bie RA, Brutel de la Riviere A, Van Meeteren NLU. Preoperative intensive inspiratory muscle training to prevent postoperative pulmonary complications in high-risk patients undergoing CABG surgery: a randomized clinical trial. JAMA 2006; 296: 1851-7.

7. Illi SK, Held U, Frank I, Spengler CM. Effect of respiratory muscle training on exercise performance in healthy individuals: a systematic review and meta-analysis. Sports Med 2012; 42: 707-24.

8. Beaumont M, Mialon P, Le Ber-Moy C, Lochon C, Péran L, Pichon R et al. Inspiratory muscle training during pulmonary rehabilitation in chronic obstructive pulmonary disease: a randomized trial. Chron Respir Dis 2018; 15: 326-35.

9. Gosselink R, De Vos J, van den Heuvel SP, Segers J, Decramer M, Kwakkel G. Impact of inspiratory muscle training in patients with COPD: a meta-analysis. Eur Respir J 2011; 37: 416-25.

10. Benzo R, Wigle D, Novotny PJ, Wetzstein M, Nichols F, Shen RK et al. Preoperative pulmonary rehabilitation before lung cancer resection: results from two randomized studies. Lung Cancer 2011; 74: 441-5.

11. Weiner P, Magadle R, Beckerman M, Weiner M, Berar-Yanay N. Specific inspiratory muscle training in COPD. Chest 2003; 124: 468-73.

12. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL et al. Standardization of spirometry 2019 update. An official ATS/ERS technical statement. Am J Respir Crit Care Med 2019; 200: e70-88.

13. Ljungqvist O, Scott M, Fearon KC. Enhanced Recovery After Surgery: a review. JAMA Surg 2017; 152: 292-8.