PILOT STUDY

Effect of deep breathing exercises in healthy smokers: A pilot study

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Abstract

Objective: To determine the effect of deep breathing exercises on lung functions in apparently healthy smokers.

Methods: The pilot study was conducted at Isra University, Islamabad, Pakistan, from May to December, 2017, and comprised apparently healthy smokers aged 20-30 years with a minimum smoking history of 5 years. The participants were divided into control and experimental groups. The control group was not given any treatment, while the experimental group was trained on deep breathing exercise techniques. Baseline data was compared after two weeks of intervention. SPSS 21 was used for data analysis.

Results: Of the 30 subjects, there were 15(50%) in each of the two groups. In the experimental group, significant changes were found in vital capacity, inspiratory capacity, tidal volume, expiratory reserve volume, force expiratory volume, and forced vital capacity ($p<0.05$). Post-intervention, all parameters improved significantly in the experimental group ($p<0.05$).

Conclusion: Deep breathing exercise techniques were found to be useful in healthy smokers for improving lung functions and delaying the development of chronic obstructive lung complications.

Keywords: Deep breathing exercises, Lung functions, Lung volumes, Lung capacities, Smokers. (JPMA 70: 1209; 2020)

DOI: https://doi.org/10.5455/JPMA.16551

Introduction

Smoking is injurious to health as cigarette contains harmful substances that cause different life-threatening diseases, like bronchitis, asthma, chronic obstructive pulmonary disease (COPD), cardiovascular diseases etc.[1] During normal breathing, oxygen is supplied to the body through blood circulation. But, in smokers, carbon monoxide (CO) is supplied to body instead of oxygen, resulting in respiratory issues, like breathlessness and coughing, in acute stages.[2] Smoking decreases lung capacity, as it contains acidic substances which start damaging the lining of the bronchi and bronchioles due to which they become inflamed and infected, resulting into coughing, shortness of breath and chest pain that leads towards chronic bronchitis.[3] Spirometry is the most common method to test the lung function. Most common values which can be measured through spirometry are force vital capacity (FVC) and forced expiratory volume in one second (FEV1).[4]

There are deep breathing exercises which help to improve oxygen saturation and lung function by increasing inhalation and exhalation.[5,6] Smokers also can use deep breathing techniques to relieve stress when trying to quit smoking.[5] Pursed-lip breathing (PLB) entails exhaling through pursed lips and inhaling through nose with mouth closed. While performing PLB, back pressure is created inside airways to splint them open, to facilitate air movement by reducing work of respiratory muscles.[7,8] Diaphragmatic breathing helps in correct use of diaphragm that decreases breathing rate, which, in turn, decreases work of breathing and reduces oxygen demand.[9,10] Power breathing significantly improves the strength of respiratory muscle, and increases the volume of lung oxygen intake.[6,11,12]

The current study was planned to determine the effects of deep breathing exercises on lung functions in apparently healthy smokers.

Subjects and Methods

The pilot study was conducted from May to December, 2017, at the Isra Institute of Rehabilitation Sciences (IIRS), Isra University, Islamabad, Pakistan. This pilot study was done to confirm the enrolment procedure and pilot data collection, and determination of intervention, assessment durations and tools for larger multicenter RCT. After approval from the institutional ethics committee, healthy smokers without apparent diagnosis of lung diseases

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Annexure: Breathing Exercise Protocol.

	Pursed Lip Breathing[12]	Diaphragmatic Breathing[8]	Powered Breathing[10]
Technique	Participants were guided to inhale through nose with mouth closed and slowly exhale through pressed lips.	Participants were instructed to place one hand below the rib cage and the other hand on chest then inhale slowly so that stomach moves out against the hand, later tighten the stomach muscle while exhaling through pursed lip	Participants were taught to inhale and exhale forcefully with some movements like to inhale forcefully move hands upward and exhale forcefully while moving hands downward.
Frequency/day	3-4/day	3-4/day	3-4/day
Repetition	10	10	10
Duration of Protocol	2 weeks	2 weeks	2 weeks

were selected from the community using non-probability convenience sampling after volunteers for the study were invited by using the campus Notice Board. Those included were male healthy smokers aged 20-30 years w3ith a minimum smoking history of 5 years who and were without any chronic pulmonary complication. Smokers with any pulmonary disease, acute infections, other systemic disease, chest deformity or any disability and history of any surgery were excluded. Those included were randomly allocated to experimental and control groups using the lottery method. All the subjects initially underwent general physical exam conducted by a physiotherapist. Lung function tests were performed by using a local spirometer (Abdul Wahab & Sons [AWS] [Pvt] Ltd.; Model #: AWS-300) with 9 litre capacity. The spirometer composed of a main tank, a thermometer, open float, counter-weight, soda lime container, valve lever, corrugated rubber tube, T. tube, mouth piece, plain rubber tube, nose clip, ink pen and AWS student kymograph (Model #: AWS-216).

The intervention included three types of breathing exercises. Every participant of the experimental group was taught PLB, diaphragmatic and powered breathing exercise (Annexure). The control group did not perform any exercise.

Data was compared at baseline after the two-week intervention. The results were expressed as mean ± standard deviation (SD) for continuous data and frequencies and percentages for categorical data. Test for normality was applied to check normality of variables. Within the groups, changes were analysed by paired sample t-test in normally distributed data and for not normal distribution, Wilcoxon Sign Rank Test was used. For between the groups differences, independent sample t-test was used for normally distributed data and Mann-Whitney U test for non-normally distributed data. All statistical analyses were done using SPSS 21, and $p<0.05$ was considered significant.

Results

Of the 54 smokers assessed, 30(55.5%) were included; 15(50%) in each of the two groups. There were no significant differences between the groups in terms of demographic features and other characteristics (Table-1).

Within the experimental group, significant changes were found in FVC, inspiratory capacity, tidal volume, expiratory reserve volume, FEV1 ($p<0.05$) (Table-2).

Post-intervention, the experimental group showed significantly better results compared to the control group (Table-3).

Table-1: Demographic detail of study participants (Experimental n=15, Control n=15).

	Groups	Mean±SD	P-value
Age (years)	Experimental	22.26±2.65	0.22
	Control	23.33±2.058	
Height (feet)	Experimental	5.48±.31	0.46
	Control	5.56±.31	
Weight (kg)	Experimental	65.53±10.30	0.30
	Control	69.53±10.48	
History of smoking (years)	Experimental	5.46±1.80	0.58
	Control	5.13±1.45	
Number of Packs/Day	Experimental	0.90±.28	0.10
	Control	1.06±.25	
Blood Pressure- Diastolic (mmHg)	Experimental	82.00±8.61	0.52
	Control	80.00±8.45	
Blood Pressure -Systolic (mmHg)	Experimental	120.00±8.45	0.63
	Control	118.66±6.39	
Respiratory Rate/min	Experimental	18.46±1.45	0.26
	Control	17.86±1.40	

Table-2: Lung function test Pre and Post within Group comparison.

Item		Group A (Experimental)			Group B (Control)		
		Mean± SD/ Median(IQR)	z-score	p-value	Mean± SD/ Median(IQR)	z-score	p-value
Chest Diameter (Inch)*	Pre	34.17±1.66	-	1.00	33.53±1.30	-	0.33
	Post	34.17±1.66			33.60±1.66		
Vital Capacity(ml)*	Pre	3779.3±312.8	-	0.01	3670.0±256.20	-	1.00
	Post	3991.0±470.5			3670.0±256.20		
Inspiratory Capacity (ml)*	Pre	2916.0±301.63		0.001	2868.0±218.37	-	0.49
	Post	3111.6±377.3	-		2858.66±237.51		
Expiratory Reserve Volume (ml)**	Pre	850(100)	-3.06	<0.001	850(150)	-1.00	0.31
	Post	930(110)			850(100)		
Inspiratory reserve volume(ml)**	Pre	2600(300)	-1.95	0.05	2700(100)	-0.44	0.65
	Post	2750(450)			2700(110)		
Tidal Volume(ml)**	Pre	250(100)	-2.98	<0.001	250(50)	-1.00	0.31
	Post	350(125)			250(100)		
Forced Expiratory Volume- FEV1 (ltr)**	Pre	3(1)	-2.64	<0.001	3(0)	0.00	1.00
	Post	4(1)			3(0)		
Forced Vital Capacity-FVC (ltr)**	Pre	4(1)	-2.64	<0.001	4(0)	0.00	1.00
	Post	5(1)			4(0)		
FEV1/FVC (%)**	Pre	75(5)	0.00	1.00	75(0)	0.00	1.00
	Post	75(5)			75(0)		
Oxygen Saturation(%)**	Pre	93(5)	0.00	1.00	92(3)	0.00	1.00
	Post	93(5)			92(3)		

*Paired Sample T-test
**Wilcoxon Sign Rank Test.

Table-3: Post-treatment lung function test between groups comparison.

Item	Group	0 Week			After 2nd Week		
		Mean± SD/ Median(IQR)	U-stat.	p-value	Mean± SD/ Median(IQR)	U-stat.	p-value
Chest Diameter*	Experimental	34.06±1.66	-	0.33	34.06±1.66	-	0.40
	Control	33.53±1.30			33.60±1.35		
Vital Capacity(ml)*	Experimental	3779.3±312.78	-	0.30	3991.00±470.94	-	0.01
	Control	3670.00±256.20			3670.00±256.20		
Inspiratory Capacity(ml)*	Experimental	2916.00±301.63	-	0.62	3111.66±377.35	-	0.02
	Control	2868.00±218.37			2858.66±237.51		
Expiratory Reserve Volume(ml)**	Experimental	850(100)	96.50	0.49	930(110)	69.50	0.07
	Control	850(150)			850(100)		
Inspiratory Reserve Volume(ml)**	Experimental	2600(300)	70.50	0.07	2750(450)	108.50	0.86
	Control	2700(100)			2700(110)		
Tidal Volume(ml)**	Experimental	250(100)	97.00	0.50	350(125)	80.50	0.17
	Control	250(50)			250(100)		
Forced Expiratory Volume- FEV1 (ltr)**	Experimental	3(1)	109.50	0.88	4(1)	64.50	0.04
	Control	3(0)			3(0)		
Forced Vital Capacity-FVC (ltr)**	Experimental	4(1)	109.50	0.88	4(1)	64.50	0.04
	Control	3(0)			4(0)		
FEV1/FVC (%)**	Experimental	75(5)	108.00	0.83	75(5)	108.00	0.83
	Control	75(0)			(75(0)		
Oxygen Saturation (%)**	Experimental	93(5)	84.00	0.22	93(5)	84.00	0.22
	Control	92(3)			93(3)		

*Independent Sample T-test
**Mann-Whitney U test.

Discussion

The current study was conducted to determine the effectiveness of deep breathing exercises in healthy smokers. The effects of deep breathing exercises are well reported and are very beneficial in both short and long terms.[5]

Deep breathing exercises have direct effect on the respiratory system as ventilation become easy and an individual can inhale maximum oxygen after normal expiration. Through breathing exercise, diaphragm fully expands and more air is inhaled in the lungs which leads toward increase in the stamina and flexibility of the respiratory muscles.[6] By deep breathing exercises, effectiveness of the intercostals muscle between the ribs cage can be improved which help to improve breathing, oxygen saturation, lung function and eventually quality of life. These exercises are easy to learn, and can be done at any place any time.[11]

The results showed that there was significant change in the vital capacity and inspiratory capacity of the experimental group. In terms of energy spent on work of breathing, deep breathing exercises are not only economical, but they also help to remove dead space ventilation by an increase in vital capacity, and, as a result, they improve alveolar ventilation.[13,14] These techniques help in emptying of the lungs during expiration. Deep breathing exercises involve isometric contraction which is responsible for increased strength of skeletal muscles and improvement of ventilatory functions.[15] There was significant change in FVC in the current study, because the deep breathing exercises techniques improved the lung function by increasing the respiratory muscle strength.[11,16] The expiratory reserved volume also significantly improved in the experimental group.

Breathing exercise techniques lower the diaphragm to fully expand the lungs on inhalation and use abdominal muscle to squeeze the air out on exhalation. Tidal volume also increases with deep breathing exercise techniques as it is visible through the results that there is significant change in the tidal volume. By deep breathing exercises, more oxygen is delivered to the blood stream.[17,18]

Seo K et al. investigated the effectiveness of diaphragmatic breathing exercises on lung function in young male smokers, and revealed significant improvements in lung functions.[18] PLB causes slower and deeper breathing pattern that increases the tidal volume and reduces the breathing rate. In PLB, diaphragm is lengthened and it improves its tension-generating capacity during inspiration that increases the inspiratory capacity.[7,19]

In the current study, all subjects were apparently healthy with normal value (75%) of FEV1/FVC in both groups. The FEV1 and FVC were reduced in both groups that was the potential marker for high susceptibility COPD.[20] The current study showed that breathing exercises significantly improved FEV1 and FCV values after two weeks in the experimental group compared to the control group.

There was no significant change regarding oxygen (O2) saturation in within-group and between-group comparisons after deep breathing exercises. The oxygen saturation level showed that mild level of respiratory distress was present among the subjects and no significant difference was found after breathing exercises. The reason behind these findings might be active smoking or shorter duration of the intervention period.

The practice of deep breathing exercises helps in increasing parasympathetic activity and reducing sympathetic activity.[21] In deep breathing exercises, lungs are expanded considerably, as the individual is in the continuous phase of inhalation with his strong voluntary control and the walls of the alveoli are stretched to the maximum extent, thus resulting in improvement in the chest compliance. Gradually, the duration of inspiration increases so that respiratory centre slowly acclimatises to withstand higher partial pressure of carbon dioxide (PCO2) and lower partial pressure of oxygen (PO2).[22] The chemoreceptors, which are located in the medulla oblongata, are stimulated by CO_2 as they are sensitive to the low amount of oxygen concentration in the blood, which, as a result, sends impulses to the respiratory centre. The respiratory centre is helpless against the strong voluntary control from the cortex, otherwise it could have started exhalation.[23] Moreover, the development of respiratory musculature and endurance decrease the onset of fatigue due to regular practice of deep breathing exercises.[24,16]

The current pilot study was limited by the relatively small sample size, use of weak lottery method for randomisation and the fact that it was conducted in a single setup. Besides, only short-term physiological effects of two weeks of deep breathing exercise were assessed. Level of physical activity was not assessed in the study at the baseline which may be a confounding factor on lung function in participants with different levels of physical activity.

Further studies are recommended with larger sample size and comparison of different types of breathing exercises to provide best and effective management strategy to improve lung function, delaying complications, and

improving quality of life in healthy smokers.

Conclusion

Deep breathing exercise techniques were found to be useful in healthy smokers for improving lung functions and delaying the development of chronic obstructive lung complications.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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