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Efficacy of Respiratory Exercise on Respiratory Function among Chronic Obstructive Pulmonary Disease patients

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Abstract: *Chronic obstructive pulmonary disease is a disease that can be prevented and treated. It causes respiratory symptoms and limitations of airflow that is caused by alveolar and airway abnormalities often due to inhalation of noxious gases and particles.**The aim:** was to assess the effect of inspiratory muscle training program on improving respiratory function of patients with chronic obstructive pulmonary disease.**Methods:**A quasi experimental research design was used. The study done at Mansoura University Hospital.A sample size of 60 subjects divided into 30 for study groupand 30 for control group.**Tools:**Interview schedule sheet which includes Socio-demographic and health profile.Diagnostic tests as ABG, CBC and pulmonary function test.* ***Results:****Therewas highly statistically significant improvement in the study group after the training program regarding ABG($PACO_2$, PAO_2,HCO_3, SaO_2), FEV1, FVC, FEV1/FVC($p<0.05$) except PH(a significant improvement only $p=0.034$).Conclusions:there was an improvement in respiratory function among chronic obstructive pulmonary disease patients.*

Keywords- *chronic obstructive pulmonary disease, dyspnea, inspiratory muscle training, quality of life, respiratory function.*

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I. Introduction

Chronic obstructive pulmonary disease is a disease which can be prevented and treated. It causes respiratory symptoms and limitations of airflow that is caused by alveolar and airway abnormalities often due to inhalation of noxious gases and particles. The chronic limitation of air flow that occurs in COPD is due to a group of diseases in small airways (eg, obstructive bronchiolitis and emphysema). The chronic inflammation leads to changes in structure, small air ways narrowing, and lung parenchyma destruction. The small airways loss cause limitation to the flow of air and dysfunction of mucociliary , is a common symptoms of this disease[1].

The World Health Organization (WHO) calculates that globally COPD will rank the third cause of death in 2030. In 2014, COPD was the third cause that leads death in the United States. In America, 24 million men and women have COPD. Half of them know that they have COPD [2]. In Egypt most studies estimated the prevalence of COPD in general population samples and not among those at high risk only. detected the prevalence of COPD among patients at risk in primary care (age ≥40 years with a history of smoking of 20 pack/years) to be 20.7%[3].

Smoking and passive smoking are the first cause of COPD. The other causes are pollution of air, infectious diseases, and genetic disorder. Smoking, passive smoking Risk factors of COPD is increased by tobacco smoke, secondhand smoke, pollution of air and alpha-1 antitrypsin deficiency these factors increase the risk of having COPD. Many diseases such as chronic bronchitis, emphysema, asthma, and infectious diseases may lead to the advancement of COPD[4].

The common signs and symptoms of COPD are the following: An acute chest illness and a productive cough is common. Cough worses in the morning and causes a production of less phlegm that is colorless, The most common symptom is dyspnea, it occurs in the person's 50s or 60s, The musical, hissing or whistling sound with breathing is wheezing. Many people wheeze, especially during when their condition starts to worsen and during exertion and Often people feel as they have pneumonia or frequent colds." Many pneumonia hospitalizations turn out to be COPD exacerbations and The following manifestations may occur when COPD starts to worsen: The intervals among acute periods of dyspnea worsening (exacerbations) become shorter, Cyanosis and the failure of right sided of heart may be found . Anorexia and weight loss occur and predict a worse prognosis [5].

The nurses play an important role in developing healthy behaviour in COPD patients . Including the following: they promote support and advice to the COPD patients and their families and, also, encourage and educate the patients to proactively treate their disease. Due to the minimal change in the function of lung as a result of interventions, nurses assess this result as an improvements in the ability of patients to do the activities of daily living [6].

Goals of treatment of COPD are the following: decrease hospitalizations, decrease and prevent exacerbations, reduce dyspnea, improve the life quality, slow progression of disease, and decrease the mortality. The treatment mainstays are cessation of smoking, when applicable, and corticosteroids and pharmacotherapy with inhaled bronchodilators. The additional therapies include vaccinations, oral phosphodiesterase-4 inhibitors, oxygen therapy for a long period in hypoxic patients and pulmonary rehabilitation[7].

The dysfunction of inspiratory muscle is a common finding in COPD patients, was found with the other factors to dyspnoea and reduced tolerance to exercise. The pulmonary rehabilitation programs (PRPs) including exercise training of whole-body improve symptoms, health related the quality of life (HRQL)and exercise capacity, are required in all COPD stages[8].

The inspiratory muscle training (IMT) has been applied frequently and is studied extensively in recent years in the COPD patients From meta-analyses of a randomized controlled trials (RCTs) in the COPD patients, it can been reported that IMT representes the only therapy that improves the function of inspiratory muscle (strength and endurance), reduces the symptoms of dyspnoea and improves the exercise capacity [9].

II. Metheodology

2.1- Design

A quasi-experimental research design with a control group was selected to achieve the aim of this study.

2.2-Setting

This study was conducted at chest department, Mansoura University Hospital. Mansoura University Hospital was established in 1972 in Mansoura city, Egypt. It is a university affiliated hospital, with a primary role in education. It is located at the middle of the Nile Delta in Egypt..

2.3- Participants

A purposive sample of 60 patients who admitted to chest department; between March 2017 to August 2017, was recruited to participate in this study when they fulfill the followinginclusion criteria: aged more than 40 years old, fulfill the criteria of COPD according to Global initiative for chronic obstructive lung disease (GOLD) 2016, COPD comorbidity and accept to participate in the study.Group 1 (n=30):have initiated hospital routine care, and served as a control group and Group 2 (n=30):haveinitiated inspiratory muscle training program beside hospital routine care and represented the study group.

2.4-Tools:

In order to collect the necessary data 5 tools will be used:Interview schedule sheet[10]. It consists of two parts. part 1(Socio-demographic and health profile) part 2(Knowledge about COPD and its treatment), physical examination, diagnostic tests for assessment of COPD patient:Arterial blood gases, complete blood count and pulmonary function test (spirometry).Clinical COPD Questionnaire (CCQ)[11].Modified Borg Scale for Perceived Dyspnea (Shortness of Breath)[12]and Observational checklists[13].

2.5-Intervention (inspiratory muscle training program):

Each patient in the study group was received two different sessions: Educational and training sessions and the period of session is 40 minutes.Educational component: Respiratory system and COPD nature, COPD medications and behavior and life style modification related to proper nutrition, energy conservation techniques, healthy sleep, dyspnea management, influenza and pneumococcal vaccine, measures to reduce risk of infection and airway irritants, smoking cessation, periodic medical follow up and exercises.Training components: Inspiratory muscle training, breathing exercises and upper and lower extremities exercises.

The developed inspiratory muscle training program was conducted in 6 sessions every two weeks for 3 months after selection of teaching methods and appropriate audiovisual aids.Each session contains both education and training and lasts for 40 minutes (20 minutes for education and 20 minutes for training). One session every two weeks in the class room of chest disease department.The components of every session are: the first session (Respiratory system , COPD nature and inspiratory muscle training exercise), second session (Complications, warning signs of complications and prevention of COPD, pursed lip breathing exercise and diaphragmatic breathing exercise), third session (COPD medication, knee extension breathing and elbow circle breathing), fourth session (Behavior and life style modifications, elbow breathing exercise and step up breathing exercise, fifth session (The rest of behavior and life style modifications, arm extensions breathing exercise and

upper extremities exercises) and sixth session (The rest of behavior and life style modifications and lower extremities exercises).

The booklet that was used in educating and training the patients contained introduction about COPD disease, the respiratory system, the nature of COPD, risk factors of COPD, signs and symptoms of COPD, complications of COPD, prevention of COPD, management of COPD that includes pharmacological and behavior and life style modifications for COPD patient, inspiratory muscle training exercise and upper and lower extremities exercises.After applying the inspiratory muscle training sessions, both study and control groups were reevaluated at the chest disease department of Mansoura University Hospital using all the study tools.Comparison of each patient's findings with the preceding one and comparison between control and study group findings were done to evaluate the effect of inspiratory muscle training in the respiratory function and related outcomes.

III. Results

TABLE (1) Shows distribution of sociodemographic characteristics among the study(n=30) and control groups(n=30).

It was clear from the table, that there was no statistically significant differences among the two groups in relation to patient's sex, marital status, level of education and occupational status (p>0.05).

Regarding age it demonstrates that 6.7% of the patients of the control group >40 years compared to 3.3% in the study group. it was surprisingly to find that 83.3% of patients of the control group >50 years compared to 86.7 in the study group. The difference observed between the two groups were no statistically significant (p=0.838).

TABLE 1. Comparison of the sociodemographic characteristics between the COPD patients=30 and the controls=30

Variable	Control group (n=30)		Study group (n=30)		Chi square test	
	N	%	N	%	X^2	P
Age (year)						
< 40	2	6.7	1	3.3		
40 – 50	3	10.0	3	10.0		
>50	25	83.3	26	86.7	0.353	0.838
Sex						
Male	20	66.7	20	66.7		
Female	10	33.3	10	33.3	0	1.000
Marital status						
Single	2	6.7	1	3.3		
Married	27	90.0	26	86.7		
Widow	0	0.0	3	10.0		
Divorced	1	3.3	0	0.0	4.352	0.226
Level of education						
Illiterate	22	73.3	22	73.3		
Basic education	4	13.3	3	10.0		
Intermediate	3	10.0	3	10.0		
University	1	3.3	2	6.7	0.476	0.924
Occupational status						
Not working	15	50.0	11	36.7		
Working	15	50.0	19	63.3	1.086	0.297

n- number

*p< 0.05 (significant)

**p< 0.001 (highly significant)

TABLES (2) indicates Comparison of the laboratory findings at pre and post training program between study patients (n=30) and between the controls (n=30) and study group (n=30) post training program.

It can be noted that there was statistically significant differences between the study group pre and post the training program and between the control and study group post the training program in relation to potential hydrogen in arterial blood (ph) ($p< 0.05$).

There was highly statistically significant differences between the study group pre and post the training program concerning partial pressure of arterial carbon dioxide (paco2), partial pressure of arterial oxygen (pao2), and oxygen saturation (sao2), forced expiratory volume in the first second (FEV1), forced vital capacity (FVC) and forced expiratory volume in the first second to forced vital capacity (FEV1/FVC) ($p<0.001$) except concerning bicarbonate (HCO3)there was statistically significant differences only ($p=0.033$).

However highly statistically significant differences between the control and study groups post the training program regarding partial pressure of arterial carbon dioxide (paco2), partial pressure of arterial oxygen (pao2),bicarbonate (HCO3), oxygen saturation (sao2), forced expiratory volume in the first second (FEV1), forced vital capacity (FVC) and forced expiratory volume in the first second to forced vital capacity (FEV1/FVC) ($p<0.001$).

TABLES 2. Comparison of the laboratory findings at pre and post training program between study patients (n=30) and between the controls (n=30) and study group (n=30) post training program.

pre	Post						Post					
Variable	study group (n=30)		Study group (n=30)		Chi square test		Control group (n=30)		Study group (n=30)		Chi square test	
	N	%	n	%	X2	P	N	%	N	%	X2	P
Arterial blood gases												
PH												
Low	13	43.3	2	6.7			3	10.0	2	6.7		
Normal	8	26.7	17	56.7			9	30.0	19	63.3		
High	9	30.0	11	63.7	11.507	0.003	18	60.0	9	30.0	6.771	0.034*
$PACO_2$												
Low	9	30.0	3	10.0			7	23.3	0	0.0		
Normal	4	13.3	18	60.0			4	13.3	28	93.3		
High	17	56.7	9	30.0	14.371	<0.001	19	63.3	2	6.7	38.762	<0.001**
PAO_2												
Low	24	80.0	11	36.7			23	76.7	7	23.3		
Normal	3	10.0	19	63.3			5	16.7	23	76.7		
High	3	10.0	0	0.0	19.465	<0.001	2	6.7	0	0.0	22.105	<0.001**
HCO_3												
Low	2	6.7	1	3.3			1	3.3	1	3.3		
Normal	12	40.0	22	33.3			8	26.7	29	96.7		
High	16	53.3	7	23.3	6.796	0.033	21	70.0	0	0.0	32.919	<0.001
SaO_2												
Low	19	63.3	6	20.0			16	53.3	2	6.7		
Normal	10	33.3	24	80.0			13	43.3	28	93.3		
High	1	3.3	0	1.7	13.525	0.0011	1	3.3	0	0.0	17.377	<0.001**
Respiratory function tests												
FEV1												
Low	27	90.0	15	36.7			27	90.0	6	20.0		
Normal	3	10.0	15	63.3	11.429	<0.001	13	10.0	24	80.0	29.697	<0.00
FVC												

Low	28	91.7	15	50.0			24	80.0	6	20.0		
Normal	2	8.3	15	50.0	13.871	<0.001	6	20.0	24	80.0	21.600	<0.00
FEV1/FVC												
Low	16	53.3	6	20.0			11	36.7	1	3.3		
Normal	14	46.7	24	80.0	7.177	0.007	19	63.3	29	96.7	10.417	<0.001**

PH- potential hydrogen PAO2-partial pressure of arterial oxygen PACO2-partial pressure of arterial carbon dioxide SAO2- oxygen saturation HCO3- bicarbonate FEV1-forced expiratory volume in the first second FVC-forced vital capacity FEV1/FVC-forced expiratory volume in the first second to forced vital capacity
*p<0.05 (significant) **p<0.001 (highly significant)

IV. Discussion

Our findings demonstrated that there was no statistically significant differences between study and control group regarding sociodemographic characteristics (homogenous groups)**(table 1)**. This result supported by a study done inShahbag, Dhaka added that all of the patients were similar as regard age, height, duration of COPD, duration of smoking, socioeconomic status and occupation[14]. This is in accordance with a study done in brazil reported that The demographic and biochemical characteristics of the patients assigned to the control and yoga groups were similar[15]. A study done in india showed that Statistically no significant difference was found in the distribution of demographic variables among the patients with COPD in experimental and control groups[16].in addition a control group including participants in an identical PR programme without IMT was recruited from the PR database of the University Hospital Leuven. These patients were individually matched to the participants of the combined intervention for the following baseline characteristics upon entry into the programme: age, sex, pulmonary function, P_{Imax}, and exercise capacity[17].

Regarding arterial blood gases test, the present study findings proved that study group showed singnificant improvement in all parameters of arterial blood gases test as regard PH, PACO2, PAO2, HCO3 and SaO2 **(table 2)**. On the same line, a study carried out in Beni-Suef Egypt reported that, there was no statistically significant difference in pH between the EMT and IMT groups (p=0.07). There were a statistically significant reduction in $PaCO_2$ in the IMT group compared with the EMT group (p=0.02), and a statistically significant increase in PaO_2 in the IMT group compared with the EMT group (p=0.005). Furthermore, there was a statistically significant increase in HCO_3 and SaO_2% in the IMT group compared with the EMT groups (p=0.0001)[18]. In support to foregoing study, in Egypt to determine Impact of the respiratory muscle training on blood gases and pulmonary function among patients with cervical spinal cord injury concluded that The mean value of respiratory rate, heart rate, partial pressure of arterial carbon dioxide and PH revealed asignificant decrease, but forced vital capacity, forced expiratory volume in the first second and partial pressure of arterial oxygen revealed a significant increase in group (A) at the study end[19]. Additionally, another study conducted in Egypt studied the efficacy of inspiratory training on blood gases and brain natriuretic peptide among patients with heart failure showed that there was a significant statistical improvement in post treatment values of brain natriuretic peptide with 29.84% , PaO2 with 53% and a non-significant statistical improvement in post treatment PaCO2 with 7.22% in the study group who uses IMT with their optimum medical treatment and traditional physical therapy sessions for a 10 days twice daily[20].

Concerning pulmonary function tests, the present study portrays that, study group showed significant improvement in all parameters of pulmonary function tests as regard FEV1(% predict), FVC(% predict) and FEV1/FVC(% predict) **(table 2)** There was a statistically significant improvement in pulmonary function in the intervention group after 3 weeks of respiratory muscle training (p<0.05). This improvement in the pulmonary function was independent of the improvement in stroke-related disabilities[21]. In the same line a study done in Portugaltodetermine The efficacy of inspiratory muscle training on the function of lung in female basketball players reported that there is an increase in the pulmonary function volumes FVC ($p < 0.001$), FEV_1 ($p < 0.001$), and PEF ($p < 0.001$) in the EG. The elevation of PEF was found in the CG ($p < 0.042$)[22]. A study added that, there was a statistically significant increase in maximal expiratory pressure (24.53 cmH_2O (10.34)), maximal inspiratory pressure (27.94 cmH_2O (8.90)), FVC (10.29% (8.18) predicted), FEV1(13.88% (13.42) predicted), forced expiratory flow 25%–75% (14.82% (12.44) predicted), peak expiratory flow (19.82% (15.62) predicted) and 6-minute walking distance (55.53 m (14.13)) in the training group ($p < 0.01$). No statistically significant changes found in the control group ($p > 0.05$)[23].

V. Conclusions And Recommendations

Inspiratory muscle training program enhances pulmonary function as there was highly statistically significant improvement in the the forced vital capacity (FVC), forced expiratory volume in the first second

(FEV1) and and the forced expiratory volume in the first second to the forced vital capacity (FEV1/FVC) and improves arterial blood gases, quality of life and dyspnea.

Recommendations:

Based on the result of the present study, the following recommendations are suggested: COPD patients should be given a written instruction plan for daily self management measures. Family members and significant others should be educated about care of patient with COPD for caring and supporting them to manage their condition. Inspiratory muscle training programs should be integrated within the plan of care for COPD patients. These programs should emphasize patient education about the disease process, COPD medications, behavior and lifestyle modifications, breathing exercises, upper and lower extremities exercise, airway clearance techniques, psychosocial support, different relaxation techniques and effective coping behaviors that patients can incorporate into their lifestyle. Mass media can play a vital role in providing the public with informations about prevention, early detection and treatment of disabling and life threatening obstructive airway disease with great focus on smoking prevention. Establishment of inspiratory muscle training unit in the chest disease department is essential to provide inpatient and outpatient inspiratory muscle training program for patients with COPD and different respiratory diseases that require inspiratory muscle training.

Other thesis with a larger patients groups are required to verify these resultsand that those studies could include the other outcomes, likeexacerbations number, the amount of used medication and the cost benefits of home based inspiratory muscle training programs, other studies are required to assess effect of long term follow up of inspiratory muscle training programs.Additional studies to identify ways to improve motivation among patients with COPD to maintain the benefits of inspiratory muscle training program.Quantitative studies exploring benefits and barriers to performing a self controlled inspiratory muscle training program and further studies to assess the benefits of early inspiratory muscle training program for COPD patients after an acute exacerbation are required.

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