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Ventilatory Response To Upper Versus Lower Limbs Exercises In Males With Chronic Obstructive Pulmonary Disease

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Abstract

Objective: This study was conducted to compare between the ventilatory response to upper versus lower limb exercises in males with COPD.

Material and methods: Thirty male patients with mild to moderate degree of COPD participated in the study, Their age ranged from 40 to 60 years .They were divided into two equal groups ; group (A) performed upper limb exercise plus receiving medical treatment, while Group (B) performed lower limb exercise program plus receiving medical treatment. The study lasted 6 weeks. Ventilatory functions were measured pre and post study for both groups.

Results: Statistically, there was significant improvement in measured values (FEV1, FVC, FEV1/FVC, and MVV) of the lower limbs exercise group in contrast to those of the upper limbs group

Conclusion: It is recommended to encourage the COPD patients to participate in lower limb exercise program to improve their ventilatory functions.

Key words: Upper limbs, Lower limbs, Exercise, Ventilatory functions, COPD

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Introduction:

Chronic obstructive pulmonary disease (COPD), also known as chronic obstructive airway disease (COAD), is a group of diseases characterized by limitation of airflow in the airway that is not only fully reversible. COPD is the umbrella term for chronic bronchitis, emphysema and a range of other diseases. It is most often due to tobacco smoking but can be due to other airborne irritants such as coal dust, asbestos or solvents (1).

Lung defense mechanisms are impaired in multiple ways in patients with COPD and other chronic lung conditions. Abnormal viscosity or volume of secretions, impaired ciliary's function, or even loss of ciliated epithelium leads to reduce mucocilliary clearance and mucus plugging. Mucus hyper-secretion in patients with COPD is closely associated with pulmonary infection and death (28).

Subjects with COPD have difficulty breathing because they develop smaller air passage ways and have partially destroyed alveoli. The air passage ways also become clogged with mucus, a slimy substance. Smoking cigarettes is the most important risk factor and cause COPD. About 80 % to 90% of COPD cases are caused by smoking, and smoker is 10 times more likely than a nonsmoker to die of COPD (25).

Chronic obstructive pulmonary disease is a leading cause of morbidity and mortality world a wide, and places a huge burden on health care resources. It is characterized by progressive airflow limitation, which is largely irreversible (14).

The prevalence of COPD is increasing. In 1994, there were approximately 16.2 million men and women suffering from COPD in the United States and more than 52 million individuals around the world. The worldwide prevalence is likely to be underestimated for several reasons, including the delay in establishing the diagnosis, the variability in defining COPD, and the lack of age-adjusted estimates. Age adjustment is important because the prevalence of COPD in individuals under 45 years old is low; while the prevalence is highest in patients over 65 years old. The prevalence in those over 65 was fourfold that in the 45-64-year-old group (26).

COPD is currently the fourth cause of morbidity and mortality in the developed world. Patients with COPD experience a progressive deterioration and disability, which lead to a worsening in their health related quality of life (HRQOL). Patients with stable COPD show a reduction of their HRQOL, even in mild stages of the disease (13).

Pulmonary function testing is used in the diagnosis of chronic obstructive pulmonary disease (COPD) and the staging of COPD severity. The current diagnostic criterion for airflow obstruction is a ratio of forced expiratory volume in 1 second (FEV1) to forced vital capacity (FVC) < 70 % (9).

A postbronchodilator spirometric measurement of forced expiratory volume in one second (FEV1) less than 80% predicted and a ratio of FEV1 to forced vital capacity (FEV1/FVC) below 70% suggest airflow limitation that is not fully reversible. "A decreased ratio is considered an early sign of COPD (6).

The key components of the pulmonary rehabilitation process are physical exercise training, education and cognitive behavioral therapy. Physical training appears to be a mandatory requirement for benefit while

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other activities support and augment the process. In terms of process, lower extremity exercise training (Brisk walking, cycling) is associated with strong evidence of benefit. Rehabilitation results in a reduction of dyspnea, improve functional exercise capacity and improvement in quality of life (16).

Statement of the problem

Were there any differences in the effect of upper limbs exercises versus lower limbs exercises on ventilatory function values in patients with chronic obstructive pulmonary disease?

Purpose of the study

To differentiate between the effect of upper and lower limbs exercises program on ventilatory function values in patients with chronic obstructive diseases.

Significance of the study

Chronic obstructive Pulmonary disease (COPD) is an defined term that is often applied to patients who have emphysema, chronic bronchitis or a mixture of the two**.** Chronic obstructive pulmonary disease gradually impairs a patient's overall physical ability and reduces health-related quality of life, (16).

Chronic obstructive Pulmonary disease is a leading cause of morbidity and mortality world a wide, and places a huge burden on health care resources. It is characterized by progressive airflow limitation, which is largely irreversible (14). Upper limb exercises program can be used in cases of COPD which have musculoskeletal disorders as osteoarthritis in knee or hip and can be used in cases of paraplegia or even amputation.

The present study tended to compare between the effects of upper and low exercise program on ventilatory function values in patients with COPD.

Hypothesis:

There was no difference between the ventilatory response to upper versus lower limbs exercises in patients with chronic obstructive pulmonary disease.

Limitations:

The study was limited by:

1- Cooperation of each patient in the exercise program which may affect the results in some way.
2- Physical and psychological status of the patients may affect treatment program.
3- Variation of functional activities between patients.

Basic assumption:

It was assumed that:

1- The primary medical assessment would be done for every participating patient.
2- Each patient would comply with the instructions and advices given to him during the study
3- Psychological and physiological conditions were the same for all patients at the time of performance.
4- All subjects were medically free of other health related disease and conditions.

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Delimitations:

1- Subjects' age would range from 40 to 60 years old.
2- The study would be conducted at Cairo University Hospitals, chest Department.
3- Subject's weight was calculated by using body mass index (BMI=weight/heihgt$^{2)}$; A BMI of 25 was taken as upper limit.
4- Stationary Bicycle and arm ergometer exercise programs were used.
5- They had no serious complications as renal failure, myocardial infarction, serious cardiovascular problems, and orthopedic problems.

Subjects, Material and Methods

This study was designed to assess the effect of moderate intensity exercise on ventilatory functions in patients with COPD and to compare between effects of upper limb exercise versus lower limb exercise in patients with COPD.

I- Subjects

Thirty male patients with moderate COPD, selected from Kasr El-Ani out-patient clinics to participate in this study.

Criteria of subjects:

1- Inclusion criteria

Age 40 to 60 years old.

1. Moderate COPD (i.e. patients with moderate ventilatory impairment with their forced expiratory volume in the 1st second (FEV_1) is ranged between 50 –80 % of predicted value, with an (FEV_1) to forced vital capacity (FVC) ratio of < 70 %(Pauwels et al.,2001).
2. Patients with incapacitating breathlessness according to medical research council of dyspnoea. That is scores of grade 3 (i.e. walking slower than people of the same age on the level because of breathlessness or have to stop for breath when walking at patient's own pace on the level) or grade 4 (i.e. stopping for breath after walking 100 yards or after few minutes on the level).
3. Patients were not highly conditioned nor engaged into close, previous regular athletic endeavors.
4. A body mass index of 25kg/m2 was taken as upper limit for each patient.
5. A physician assessed all subjects before starting the study procedures.

2- Exclusion criteria

Any patient suffers from the following diseases:

1- Renal failure
2- Myocardial infarction
3- Serious cardiovascular problems
4- Orthopedic problems
5- Atrial or ventricular arrhythmia

The patients were randomly assigned into two equal groups:

Group A

Fifteen male patients received upper limb exercise. The exercise was performed daily for 6 weeks. The exercise was performed on arm ergometer with moderate work load, i.e. score 12-14 on Borg scale for RPE (Appendix 2), for 30 minutes. They also received the prescribed pharmacological treatment as bronchodilators, mucolytics, Antibiotics, and anti-inflammatory agents.

Routinely cardio-vascular examination including normal resting blood pressure determined by reported value, normal ECG including the absence of documented atrial or ventricular arrhythmia before the exercise training.

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Group B:

Fifteen male patients participated in a supervised moderate intensity aerobic lower limb exercise program performed daily for 6 weeks. The aerobic exercise was performed on a stationary bicycle with moderate work load, i.e. score 12-14 on Borg scale for RPE for 30 minutes. They also received the prescribed pharmacological treatment as bronchodilators, mucolytics, Antibodies, and anti-inflammatory agents.

II-Equipments

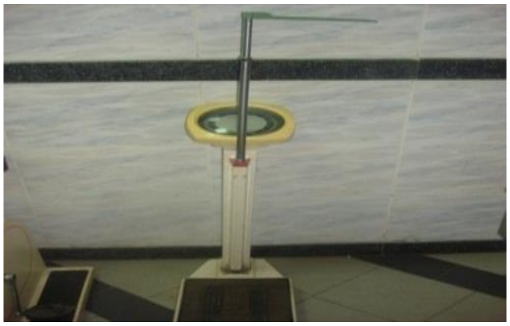
A- Measuring (evaluating) equipments: -

(1) Standard Weight and height scale was used to measure the weight and height of each participant and consequently calculate the body mass index (BMI = weight/height^2) to select subjects with acceptable weight, figure (10).

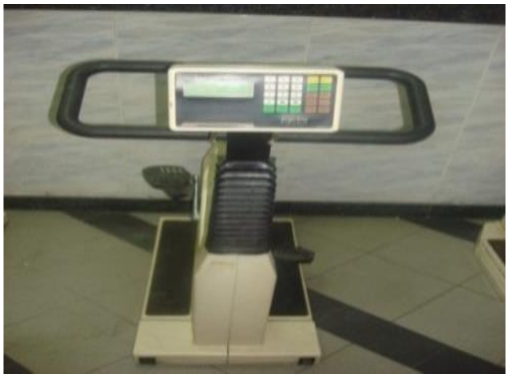
(2) Mercurial sphygmomanometer and stethoscope for measuring blood pressure and consequently the subjects with controlled blood pressure were selected according to physician guidance.

(3) The Medical Research Council scale of dyspnea was used for assessment of breathlessness grade before and after exercising.

(4) Computerized electronic cardiopulmonary fitness spirometer (ERICH- Jaeger, GmpH model, No: P-556 BA) was used to evaluate ventilatory functions [vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in the 1st second (FEV_1), forced expiratory volume in the 1st second/forced vital capacity (FEV_1/FVC) and maximum voluntary ventilation (MVV)] before and after the performance of the procedures of the study, figure (13).



Weight and height scale.



Stationary Bicycle

Arm ergometer

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II-Procedures of the study:

A- Evaluative procedures:-

1- Each patient had full explanation of the objectives of the study, demonstration on equipments, and procedures. Those patients who agreed to participate in the study signed an informed consent for participation (Appendix 1).

2- Data concerning each subject characteristics were collected in the first session including height, weight, blood pressure and dyspnoea grade.

3- Ventilatory function values (including FVC, FEV_1 FEV_1/FVC and MVV) were measured (as an initial evaluation) for each subject.

Caution:

It is extremely important that each patient be instructed and coached to perform the test properly. Expiration must be after a maximal inhalation, initiated as rapidly as possible and continued with maximal effort until no more air can be expelled.

4- Calibration of instruments was performed before each session.

Ventilatory function test using the spirometer

Moderate intensity exercise training on the stationary bicycle

Moderate intensity exercise training on the arm ergometer.

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B-Treatment procedures:

5- Each patient in-group (A) participated in a well-established aerobic exercise-training program on an arm ergometer with moderate intensity at 65-75 % of HR_{Max}. (HR_{Max} = 220-age), and in regarding to moderate work load, i.e. score 12-14 on Borg scale for rate of perceived exertion (RPE)(According to Borg scale).

6- Each patient in-group (B) participated in a well-established aerobic exercise-training program on a stationary bicycle with moderate intensity at 65-75 % of HR_{Max}., and in regarding to moderate work load, i.e. score 12-14 on Borg scale for rate of perceived exertion(RPE)(According to Borg scale).

7- Each session (the exercise program) consisted of three phases which are: warm up (5minutes) at low speed then an aerobic exercise (stimulus) phase (20minutes of moderate intensity aerobic exercise) and cool down (5minutes) at low speed in slow rhythm. The total session will be of 30 minutes.

8- Each patient practiced the exercise training program daily for 6 weeks.

C-Final evaluation:

9- Ventilatory function values and the rate of perceived exertion grade were re-evaluated after the end of the course of the study (after the end of 6th week) as a final evaluation.

N.B. Each patient participated in the exercise training program according to the individualized $HR_{max.}$

Results:

General Characteristics of the Subjects:

In this study, thirty patients with COPD were assigned randomly into two groups.

Group (A):

Fifteen patients were included in this group. The data in table (4) and (Fig.16) represented their mean age (53.26±5.48) years, mean weight (69.2±8.99) Kilogram (kg), mean height (1.63±0.05) meter (m) and mean BMI (27.75±5.78) Kg/m^2. They received upper limb exercise with arm ergometer.

Group (B):

Fifteen patients were included in this group. The data in table (2) and (Fig.16) represented their mean age (54.33±5.44) years, mean weight (73.06±10.7) Kilogram (kg), mean height (1.67±0.07) meter (m) and mean BMI (26.11±3.64) Kg/m^2. They received lower limb exercise with stationary bicycle.

There was no significant difference between both groups in their ages, Weight, heights, and BMI where their t and P-values were (0.53, 0.59), (1.07, 0.29) , (1.6, 0.12) ,and (0.93, 0.36) respectively.

Physical demographic of patients in both groups (A&B).

Items	Group A		Group B		Comparison		S
	Mean	±SD	Mean	±SD	t-value	P-value	
Age (yrs)	53.26	±5.48	54.33	±5.44	0.53	0.59	NS
Weight (Kg)	69.2	±8.99	73.06	±10.7	1.07	0.29	NS
Height (cm)	1.63	±0.05	1.67	±0.07	1.6	0.12	NS
BMI (Kg/m^2)	27.75	±5.78	26.11	±3.64	0.93	0.36	NS

*SD: standard deviation, P: probability, S: significance, NS: non-significant.

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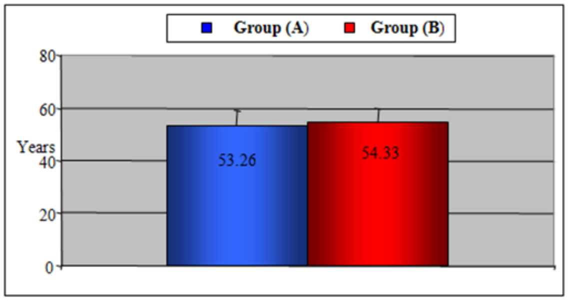
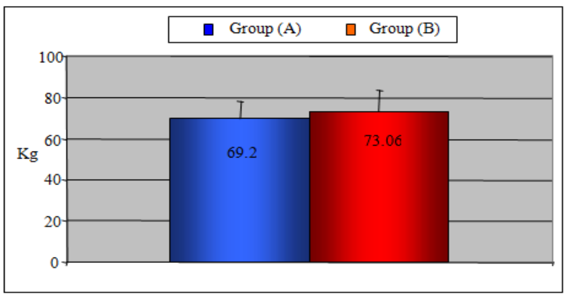
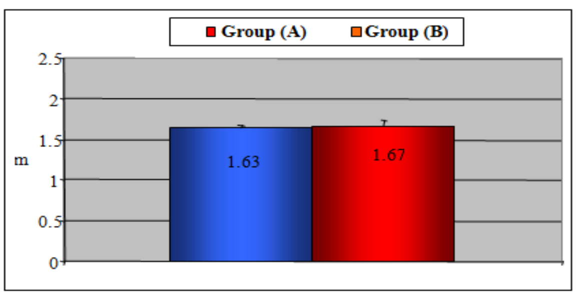


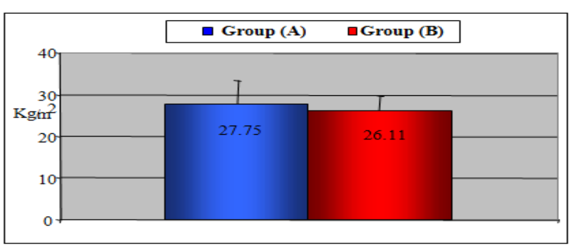
Mean and SD of the age for groups (A, B).



Mean and SD of the weight for groups (A, B).



Mean and SD of the height for groups (A, B).



Mean and SD of the BMI for groups (A, B).

Forced vital capacity:

i) Within Subjects:

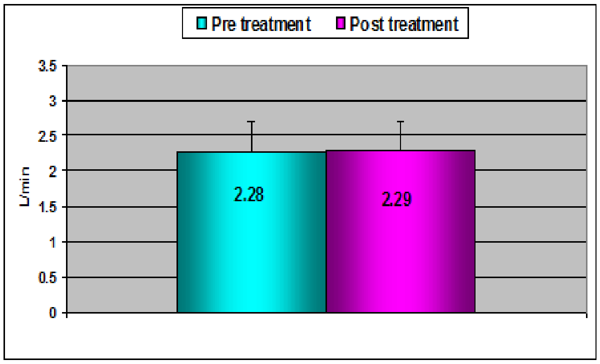
Group (A):

Table (2) demonstrated the Forced vital capacity pre and post treatment for group (**A**). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**2.28±** 0.45) and for post treatment was (**2.29**±0.46) where the t-value was (0.37) and P-value was (0.71). The Percentage of Improvement between pre and post treatment values was (0.35%).

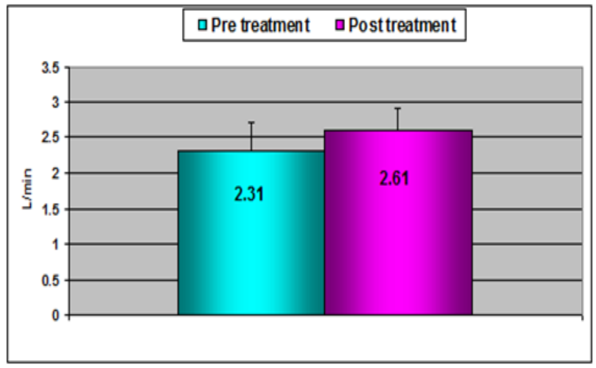
Mean and SD, t and P values of Forced vital capacity pre and post treatment of group (A).

Group A (Upper Limb Group)	Forced vital capacity	
	Pre treatment	Post treatment
Mean	2.28	2.29
±SD	±0.45	±0.46
Mean difference	0.008	
Percentage of Improvement	0.35 %	
DF	14	
t-value	0.37	
P-value	0.71	
S	NS	

*SD: standard deviation, P: probability, S: significance, S: significant, DF: degree of freedom



Mean and SD of Forced vital capacity pre and post treatment of group (**A**).



Mean and SD of Forced vital capacity pre and post treatment of group (B).

Group (B):

Table (3) demonstrated the Forced vital capacity pre and post treatment for group (B). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**2.31± 0.41**) and for post treatment was (**2.61±0.36**) where the t-value was (2.75) and P-value was (0.01). The Percentage of Improvement between pre and post treatment values was (**12.98** %).

Mean and SD , t and P values of Forced vital capacity pre and post treatment of group (B).

Group B (Lowe Limb Group)	Forced vital capacity	
	Pre treatment	Post treatment
Mean	2.31	2.61
±SD	±0.41	±0.36
Mean difference	0.3	
Percentage of Improvement	12.98%	
DF	14	
t-value	2.75	
P-value	0.01	
S	S	

*SD: standard deviation, P: probability, S: significance, NS: non-significant, DF: degree of freedom

ii) Between Groups:

Revealed the independent t-test results for the Forced vital capacity pre and post treatment between groups A and B. There was no significant difference in pre treatment values where the t-value was (0.19) and p-valu

was a significant difference in the post treatment values (P<0.05) where the t-value was (2.1) and p-value was (0.04).

Independent t-test between groups A and B for Forced vital capacity pre and post treatment.

Independent t-test	Forced vital capacity	
	Pre	Post
Mean difference	0.03	0.32
t-value	0.19	2.1
P-value	0.84	0.04
S	NS	S

*SD: standard deviation, P: probability, S: significance, NS: non-significant, S: significant.

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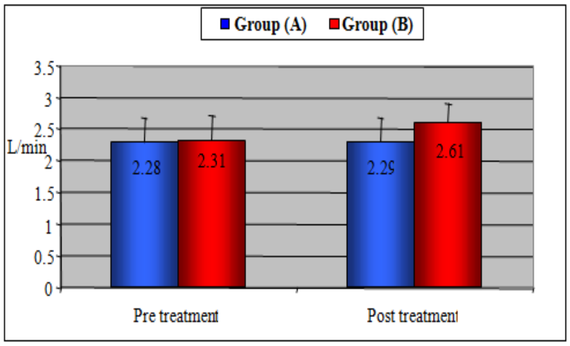
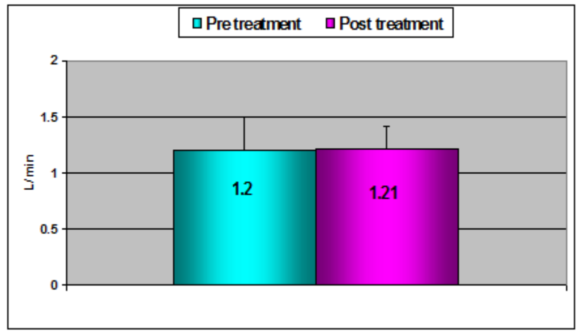


Mean and SD of Forced vital capacity pre and post treatment of groups (A,B).



Mean and SD of FEV1pre and post treatment of group (**A**).

Forced Expiratory volume (FEV1):

i) Within Subjects:

Group (A):

Demonstrated the **Forced Expiratory volume in the 1st second (**FEV1**)** pre and post treatment for group (**A**). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**1.2±** 0.3) and for post treatment was (**1.21**±0.29) where the t-value was (0.86) and P-value was (0.39). The Percentage of Improvement between pre and post treatment values was (0.83 %).

Mean and SD , t and P values of FEV1pre and post treatment of group (A).

Group A (Upper Limb Group)	FEV1	
	Pre treatment	Post treatment
Mean	1.2	1.21
±SD	±0.3	±0.29
Mean difference	0.01	
Percentage of Improvement	0.83 %	
DF	14	
t-value	0.86	
P-value	0.39	
S	NS	

Group (B):

Table (6) demonstrated the FEV1pre and post treatment for group (B). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**1.27± 0.29**) and for post treatment was (**1.51±0.32**) where the t-value was (7.09) and P-value was (0.0001). The Percentage of Improvement between pre and post treatment values was (**18.11**%).

Mean and SD, t and P values of FEV1pre and post treatment of group (B).

Group B (Lowe Limb Group)	FEV1	
	Pre treatment	Post treatment
Mean	1.27	1.51
±SD	±0.29	±0.32
Mean difference	0.23	
Percentage of Improvement	18.11%	
DF	14	
t-value	7.09	
P-value	0.0001	
S	S	

*SD: standard deviation, P: probability, S: significance, NS: non-significant, DF: degree of freedom

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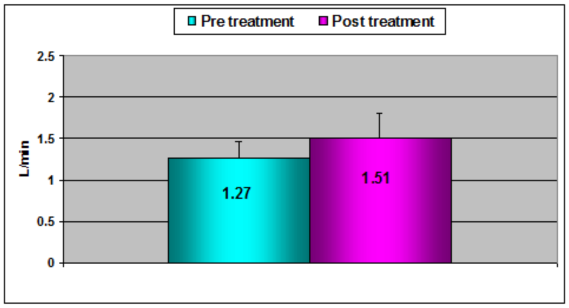
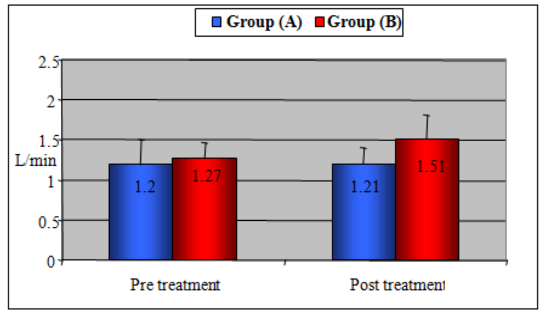


Mean and SD of FEV1pre and post treatment of group (B).



Mean and SD of FEV1 pre and post treatment of group (A,B).

ii) Between Groups:

Revealed the independent t-test results for the FEV1 pre and post treatment between groups A and B. There was no significant difference in pre treatment values where the t-value was (0.66) and p-value was (0.51). But there was a significant difference in the post treatment values ($P<0.05$) where the t-value was (2.67) and p-value was (0.01).

Independent t-test between groups A and B for FEV1**pre and post treatment.**

Independent t-test	FEV1	
	Pre	Post
Mean difference	0.07	0.29
t-value	0.66	2.67
P-value	0.51	0.01
S	NS	S

*SD: standard deviation, P: probability, S: significance, NS: non-significant, S: significant.

FEV1/FVC:

i) Within Subjects:

Group (A):

Demonstrated the **FEV1/FVC** pre and post treatment for group (**A**). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**53.32±** 10.42) and for post treatment was (**53.44**±10.28) where the t-value was (0.13) and P-value was (0.89). The Percentage of Improvement between pre and post treatment values was (0.22 %).

Mean and SD , t and P values of FEV1/FVC pre and post treatment of group (A).

Group A (Upper Limb Group)	FEV1/FVC	
	Pre treatment	Post treatment
Mean	53.32	53.44
±SD	±10.42	±10.28
Mean difference	0.12	
Percentage of Improvement	0.22 %	
DF	14	
t-value	0.13	
P-value	0.89	
S	NS	

*SD: standard deviation, P: probability, S: significance, S: significant, DF: degree of freedom

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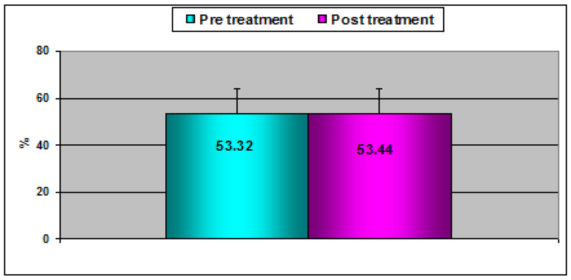


Mean and SD of **FEV1/FVC** pre and post treatment of group (**B**).

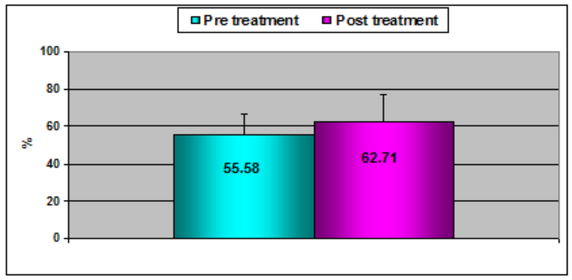
Group (B):

Demonstrated the **FEV1/FVC** pre and post treatment for group (B). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**55.58± 10.98**) and for post treatment was (**62.71±14.01**) where the t-value was (6.0) and P-value was (0.0002). The Percentage of Improvement between pre and post treatment values was (**12.82**%).

Mean and SD , t and P values of FEV1/FVC pre and post treatment of group (B).

Group B (Lowe Limb Group)	FEV1/FVC	
	Pre treatment	Post treatment
Mean	55.58	62.71
±SD	±10.98	±14.01
Mean difference	7.13	
Percentage of Improvement	12.82%	
DF	14	
t-value	6.0	
P-value	0.0002	
S	S	

*SD: standard deviation, P: probability, S: significance, NS: non-significant, DF: degree of freedom



Mean and SD of **FEV1/FVC** pre and post treatment of group(B) .

ii) Between Groups:

Revealed the independent t-test results for the **FEV1/FVC** pre and post treatment between groups A and B. There was no significant difference in pre treatment values where the t-value was (0.57) and p-value was (0.56). But there was a significant difference in the post treatment values ($P<0.05$) where the t-value was (2.06) and p-value was (0.04).

Independent t-test between groups A and B for FEV1/FVC pre and post treatment.

Independent t-test	FEV1/FVC	
	Pre	Post
Mean difference	2.26	9.26
t-value	0.57	2.06
P-value	0.56	0.04
S	NS	S

*SD: standard deviation, P: probability, S: significance, NS: non-significant, S: significant.

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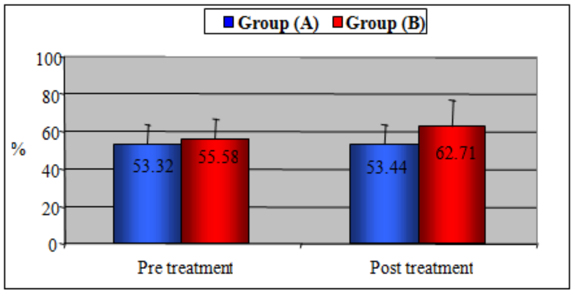


Mean and SD of **FEV1/FVC** pre and post treatment of groups (A,B).

<u>Maximum Voluntary Ventilation (MVV):</u>

<u>i) Within Subjects:</u>

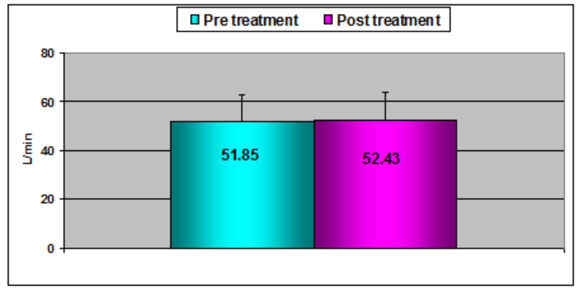
Group (A):

Table (11) demonstrated the **Maximum Voluntary Ventilation (MVV)** pre and post treatment for group (**A**). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**51.85±** 10.95) and for post treatment was (**52.43**±11.32) where the t-value was (1.4) and P-value was (0.18). The Percentage of Improvement between pre and post treatment values was (1.09 %).

Mean and SD , t and P values of MVV pre and post treatment of group (A).

Group A (Upper Limb Group)	MVV	
	Pre treatment	Post treatment
Mean	51.85	52.43
±SD	±10.95	±11.32
Mean difference	0.57	
Percentage of Improvement	1.09 %	
DF	14	
t-value	1.4	
P-value	0.18	
S	NS	

*SD: standard deviation, P: probability, S: significance, S: significant, DF: degree of freedom



Mean and SD of **MVV** pre and post treatment of group (**A**).

Group (B):

Demonstrated the **MVV** pre and post treatment for group (B). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**52.37± 6.7**) and for post treatment was (**61.56**±**4.36**) where the t-value was (**11.74**) and P-value was (0.00001). The Percentage of Improvement between pre and post treatment values was (**17.52**%).

Mean and SD , t and P values of MVV pre and post treatment of group (B).

Group B (Lowe Limb Group)	MVV	
	Pre treatment	Post treatment
Mean	52.37	61.56
±SD	±6.7	±4.36
Mean difference	9.18	
Percentage of Improvement	17.52%	
DF	14	
t-value	11.74	
P-value	0.00001	
S	S	

*SD: standard deviation, P: probability, S: significance, NS:non-significant, DF: degree of freedom

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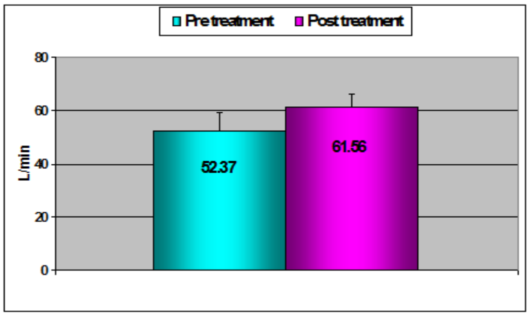


Mean and SD of **MVV** pre and post treatment of group (B).

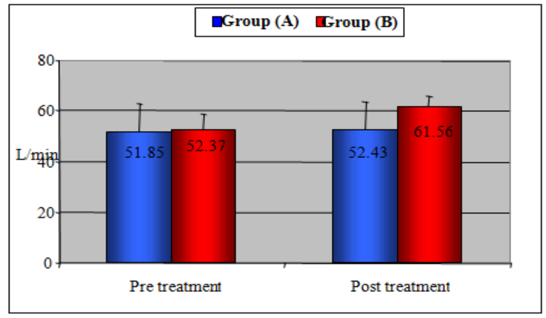
ii) Between Groups:

Revealed the independent t-test results for the **MVV** pre and post treatment between groups A and B. There was no significant difference in pre treatment values where the t-value was (0.15) and p-value was (0.87). But there was a significant difference in the post treatment values (P<0.05) where the t-value was (2.91) and p-value was (0.007).

Independent t-test between groups A and B for MVV pre and post 3treatment

Independent t-test	MVV	
	Pre	Post
Mean difference	0.52	9.13
t-value	0.15	2.91
P-value	0.87	0.007
S	NS	S

***SD**: standard deviation, P: probability, S: significance, NS: non-significant, S: significant.



Mean and SD of **MVV** pre and post treatment of groups (A,B).

Disscussion:

Chronic obstructive pulmonary disease (COPD) is a preventable and treatable disease state characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and is associated with an abnormal inflammatory response of the lungs to noxious particles or gases, primarily caused by cigarette smoking. Although COPD affects the lungs, it also produces significant systemic consequences. In patients with chronic obstructive pulmonary disease, disease severity and prognosis are determined not only by lung function impairment. In patients with mild, moderate, or severe disease, exercise capacity, health-related quality of life, and participation in activities of daily living are often impaired out of proportion to lung function impairment (17). Thirty male patients with COPD participated in this study. They were selected from Kasr EL-Aini hospital and were examined to exclude any one with renal disease, liver disorders, sever cardiac problems as heart failure, ischemic heart disease, coronary artery by pass graft, skeletal deformities as scoliosis, kyphosis and kyphoscoliosis, neurological dysfunction as cerebral stroke ,

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neuropathy, psychological or mental disorders.

All the participants were equally divided into two studied groups: group (A) and group (B). Each patient in the group (A) performed the upper limb exercise program using arm ergometer for 30 minutes, daily for six weeks. Group (B) performed lower limb exercise program using stationary bicycle for 30 minutes, daily for six weeks.

The upper extremities play an important role in many activities of daily living such as bathing, dressing, hang out the wash, and gardening. Patients with COPD frequently experience marked dyspnea and fatigue when performing these simple tasks (18)

The effectiveness of Lower limb (LL) exercise training for patients with COPD has been will documented, with consistent and clinically significant improvements in exercise capacity, symptoms, and quality of life (2).

The measured pulmonary functions in this study were forced vital capacity (FVC), forced expiratory volume in 1st second (FEV_{1}), forced expiratory volume in 1st second/ forced vital capacity ratio (FEV_1/FVC) and maximal voluntary ventilation (MVV). These measurements were recorded before the training program for each subject in both groups and were repeated in the same manner at the end of the 6th week of training program for both groups.

These measurements were selected for use in this study as they measure the integrity of respiratory system, elastic recoil of the lung and airway resistance as well as strength and endurance of the respiratory muscles (29).

Ventilatory functions responses to the moderate intensity exercise program in the group (A) was compared with that of the group(B).

The benefits of exercise training of the current study were prospective and generalized reflecting on many aspects; firstly after adherence of patients to the current study, they have been encouraged and motivated to participate in a regular exercise program as they physically felt the benefits of exercises in the form of overall improvement in the performance of ordinary activities of daily living, this functional improvement occurred through reducing respiratory limitations that hindering COPD patients from maintenance of normal activities. Secondly the psychological status of the subject has been improved resulting in more independence, more social interaction and more activities. Finally, the quality of life of patients has been enhanced in great aspect.

The results of this study showed that there was no significant difference in pre treatment pulmonary functions between group (A) and group (II). Also, the study proved that exercise training program with moderate intensity by using stationary bicycle after six weeks exercise program significantly increase the ventilatory functions of COPD patients. These results were compared with those of the group (A) which showed no significant improvement in ventilatory functions.

The results of this study concerning forced vital capacity (FVC) had indicated that there was a significant difference between the pre-treatment measured (FVC) values and the post-treatment (FVC) values of group (B). But there was no significant difference between the pre-study and the post-study (FVC) values of the group (A). Furthermore, there was a significant difference between

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the (FVC) post-study values of the two groups.

Application of moderate intensity lower limb exercise for COPD patients resulted in a significant improvement of forced vital capacity (FVC). The increase in FVC observed in COPD patients received moderate intensity bicycle exercise program may be related to the enhance strength of the skeletal muscles following training. As well as the process of motivation which enforce the patient to take deep inspiration and fill all air passages (20).

The results of this study concerning forced expiratory volume in the 1^{st} second (FEV_I) had indicated that there was a significant difference between the pre-treatment measured (FEV_I) values and the post-treatment (FEV_I) values of the group (B). But, there was no significant difference between the pre-study and the post-study (FEV_1) values of the group (A). Furthermore, there was a significant difference between the (FEV_I) post-study values of the two groups.

The significant results of FEV_1 obtained after application of moderate intensity exercise program suggested that these changes may be due to marked improvement in skeletal muscle function, especially lower limb muscles since quadriceps strength was significantly correlated with the FEV_1(20).

The significant results of FEV_1 obtained after application of moderate intensity lower limb exercise program may be due to marked decrease of airway resistance and improved immune response following exercise (21).

The results of this study concerning (FEV_I/FVC) had indicated that there was a significant difference between the pre-treatment measured (FEV_I/FVC) values and the post-treatment (FEV_I/FVC) values of the group (B). But, there was no significant difference between the pre-study and the post-study (FEV_1/FVC) values of the group (A). Furthermore, there was a significant difference between the (FEV_I/FVC) post-study values of the two groups.

The results of this study concerning (MVV) had indicated that there was a significant difference between the pre-treatment measured (MVV) values and the post-treatment(MVV) values of the group(B). But there was no significant difference between the pre-study and the post-study (MVV) values of the group (A). Furthermore, there was a significant difference between the (MVV) post-study values of the two groups.

The possible explanation for the improvement of MVV following the moderate intensity bicycle exercise program may be the increase in the efficiency of the respiratory muscles, decreasing the work of breathing, reduction in oxygen cost of breathing and relaxing accessory muscles (27).

The difference between the two groups may be due to that upper extremity exercise is associated with greater ventilatory demand compared to lower extremity exercise. Therefore, there may be reason to expect some crossover between upper extremity and ventilatory muscle function.

In group (A), the performance of arm exercise may displace the respiratory functions of scapular belt muscle to a more antigravitational function, thus increasing the work done by the diaphragm and the ventilatory demand. In addition, exercise with the arm elevated keeps the arm muscle under high tension and decrease the arm blood flow, as the increase in adrenergic

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vasomotor tone during exercise results in constriction of the vessels. This response seems to be more pronounced in small muscle groups, as the arms thus causing early muscle fatigue and shortening the length of time for any arm activity (30).

While in group (B), the arms are supported and relaxed that decreasing load on muscles of shoulders and upper limbs and so increasing their contribution to the ventilatory demand. This explains the more improvement in ventilatory functions in lower extremity training.(15), found that patient with COPD who were reporting dyspnea limitation for arm exercise were more likely to demonstrate thoracoabdominal dyssnchrony during exercise. They postulated that ventilatory muscle fatigue was more likely to result from upper extremity exercise because of added burden on the accessory muscles in supporting the arms during such exercise.

Arm ergometry was associated with lower maximum oxygen consumption and with a lower power output than leg ergometry. These findings are similar to those described in normal subjects. This is not surprising since the volume of the leg musculature is considerably greater than that of the arms, allowing the performance of greater levels of exercise (24).

Upper limb activities commonly require arm exercise, which poses a unique challenge for patients with COPD, whose upper limb muscles are required to act as accessory muscles of respiration. During arm exercise, the participation of the accessory muscles in ventilation decreases, and there is a shift of respiratory work to the diaphragm. This is associated with sever dyspnea, and termination of exercise at low workload, especially in patients with more sever bronchial obstruction (22).

Upper extremity exercise is associated with a significant metabolic and ventilatory cost that is particularly evident in patients with chronic airflow obstruction. In these patients abnormal ventilatory muscle recruitment has been hypothesized to relate to impaired diaphragm function resulting from hyperinflation (12).

Although arm exercise is often intermittent and relieved by rest periods, patients with COPD frequently report limitations in these activities. These can be attributed to various factors. Firstly, muscles involved in upper extremity exercise are also necessary for breathing and arm exercise is associated with dyssynchronous breathing in patients with COPD. Secondly, body positions that involve bracing of the arms enable the patient to obtain higher levels of ventilation, presumably because arm bracing limits upper extremity activities. Thirdly, for equal work rates, ventilation and oxygen consumption are generally higher for arm than for leg exercise. This is probably due to an earlier onset of anaerobic metabolism for the arms than for the legs. Moreover, static muscle work to stabilize the trunk and shoulder during upper extremity exercise contributes to a lower mechanical efficiency of arm exercise (1)

(3), postulated that an increase in the 6-min walk distance (6MWD) increase with lower extremity training but not with upper extremity training.

(7),found that arm work is reduced by 38% that of the legs, while more modest reductions are noted for Vo**2** and V**E,** suggesting greater mechanical efficiency for leg work as compared to arm work. They also found that that peak arm ergometry

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performance is lower than that for legs. Peak gas exchange indexes trended higher for legs as compared to arm work.

The results of this study was supported with (5), who reported no improvement in ventilatory muscle endurance from arm cycle training in patients with COPD.

Also, the result of this study come in agreement with the finding of (8), who applied supported versus unsupported arm exercise on patients with stable COPD. They found that there are no significant changes in pulmonary functions including FEV1, FEV1/FVC ratio and FRC after pulmonary rehabilitation program that includes both supported and unsupported arm exercise.

These finding and explanation of this study was confirmed also by (23), who found that peak Vo2 and peak VE were significally lower for arm exercise test than for leg exercise test. Mechanical constraint to ventilation during exercise test would have resulted from restriction to chest wall expansion when arm is elevated in addition the chest wall muscles act to position and stabilize the arms.

The result of this study come in agreement with (15), who demonstrated that patients with COPD performing exercises on arm cycle ergometer developed dynamic lung hyperinflation, increased dyspnea and upper limbs fatigue. Apparently patients develop a lower level of dyspnea during lower limbs exercises than during upper limbs exercises.

The result of the current study was also supported by (4), who postulated that lower limb exercise improve physical capacity in moderate to sever COPD patients.

On the other hand, the results of this study are contradicted with the study of who applied supported versus unsupported arm exercise in COPD patients. They concluded that both groups showed significant improvement in FEV1, FVC and FEV1/FVC with no statistical difference between both groups. The deviation of the result may be related to difference in subject criteria as they had sever COPD and they applied the study on a wide range of age between 43 to 76 years.

The results of this study was also contradicted with (19), who reported that VC and FEV**1** didn't change significantly after lower exercise program. The possible explanation of this contradiction may be the short duration of the treatment (only two weeks of aerobic exercise).

Finally, In a contradict study that conducted by (11), who postulated that upper limb exercise improve ventilatory functions. The difference in results between the recent study and that study may be due to different protocol and different criteria of subjects they studied as they applied arm exercise with breathing exercise and incentive spirometer and their study was applied on welders.

CHAPTER VI

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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