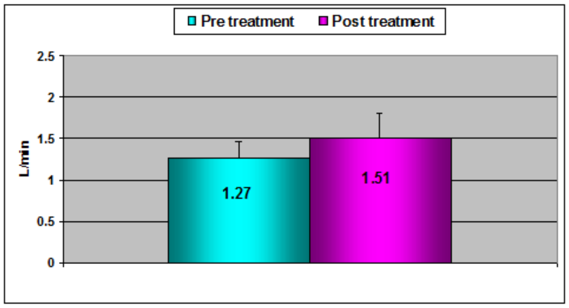


Mean and SD of FEV1pre and post treatment of group (B).

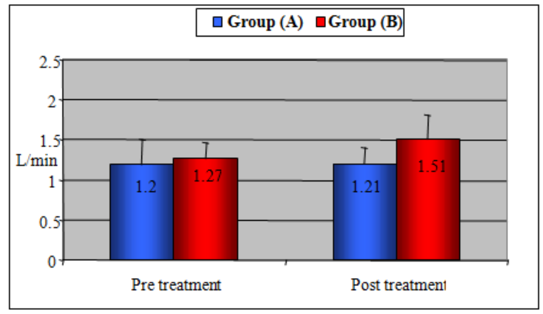
ii) Between Groups:

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.



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

FEV1/FVC:

i) Within Subjects:

Group (A):

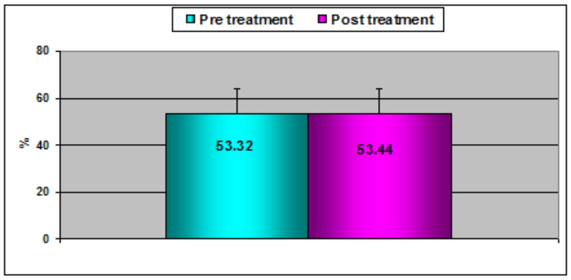
Demonstrated the **FEV1/FVC** pre and post treatment for group (**A**). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**53.32±** 10.42) and for post treatment was (**53.44**±10.28) where the t-value was (0.13) and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

Corresponding Author: Dr. Gohar Mohammed Gohar



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

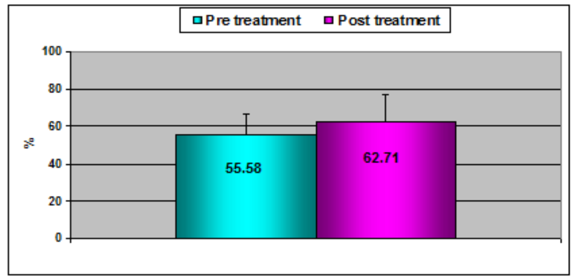
Group (B):

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).

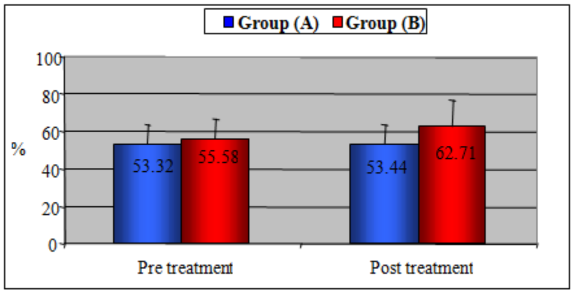
Independent t-test between groups A and B for FEV1/FVC pre and post treatment.

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.

Corresponding Author: Dr. Gohar Mohammed Gohar

South Valley University-International journal of physical therapy and science (SVU-IJPTS)



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

Maximum Voluntary Ventilation (MVV):

i) Within Subjects:

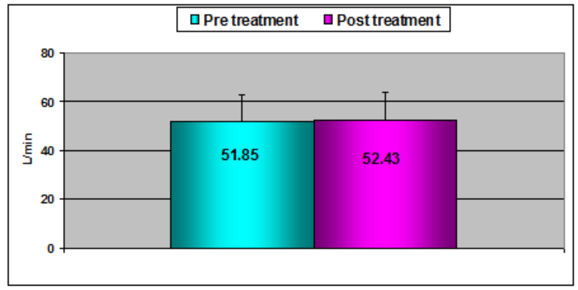
Group (A):

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):

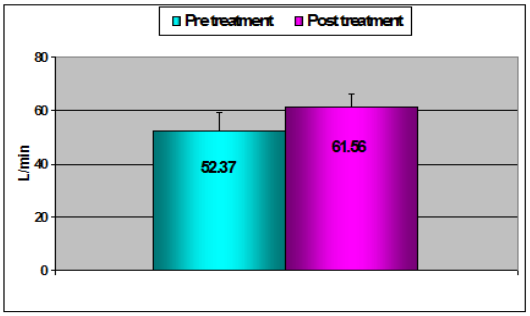
Demonstrated the **MVV** pre and post treatment for group (B). There was no significant difference in the paired t-test between pre and post treatment values as the mean value of pre treatment was (**52.37**± **6.7**) and for post treatment was (**61.56**±**4.36**) where the t-value was (**11.74**) and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

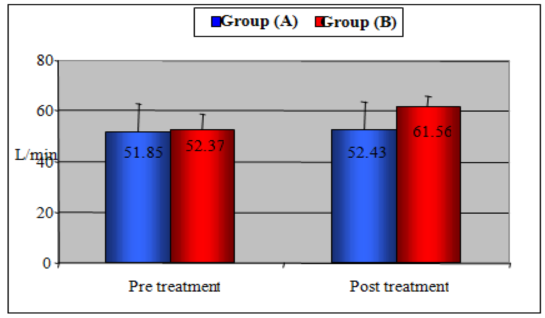
Group B (Lowe Limb Group)	MVV	
	Pre treatment	Post treatment
Mean	52.37	61.56
±SD	±6.7	±4.36
Mean difference	9.18	
Percentage of Improvement	17.52%	
DF	14	
t-value	11.74	
P-value	0.00001	
S	S	

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

Corresponding Author: Dr. Gohar Mohammed Gohar



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



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

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 ,

Corresponding Author: Dr. Gohar Mohammed Gohar

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

Corresponding Author: Dr. Gohar Mohammed Gohar

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 1st 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

Corresponding Author: Dr. Gohar Mohammed Gohar

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

Corresponding Author: Dr. Gohar Mohammed Gohar

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.

Corresponding Author: Dr. Gohar Mohammed Gohar

References:

1. **Agusti A., Anzueto A., Berg B., Buist A.S., Calverley P.M.A., Chavannes N. et al., (2004):** "Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper". Eur Respir J; 23: 932–946
2. **American Thoracic Society Statement.(1999)**:"Pulmonary rehabilitation", Am J Respir Crit Care Med;159:1666-82
3. **American Thoracic Society/European Respiratory Society.(1999):** "Skeletal muscle dysfunction in chronic obstructive pulmonary disease" : a statement of the American Thoracic Society and European Respiratory Society, Am J Respir Crit Care Med;159:S1–S40.
4. **Anoma S., Suwanne J. Wattana J. Somachi C., Supoj S.(2009):** "Effect of lower extremity exercise on muscle strength and physical capacity in COPD patients", J Med. Assoc. Thai., 92(4):556-63
5. **Belman MJ, Kendregan BA. (1982):** "Exercise training fails to increase skeletal muscle enzymes in patients with chronic obstructive pulmonary disease", Am Rev Respir Dis;123:256–261.
6. **Bethesda MD. (2001): "**COPD guidelines go global**":** Pulmonary Reviews Magazine vol.6 No.7, July.
7. **Carter R, Holiday DB, Stoks J, Tiep B.(2003)**: "Peak physiology responses to arm and legergometry in male and female patients with air flow obstruction". Chest; 124:511-8
8. **Celli. B., Criner G. and Russlo. J. (1988): "**Ventilatory muscle recruitment during unsupported arm exercise in normal subjects". Journal of applied physiology; 64(5): 1936-1941,
9. **Cooper B. (2005):** "Assessment of Pulmonary Function in COPD " Respir Crit Care Med.;26(2):246-252.
10. **Devereux G.(2006):"**ABC of chronic obstructive pulmonary disease: Definition, epidemiology, and risk factors**"**, BMJ ;332:1142-1144
11. **El-Batanouny MM, N.M. Amin Abdou, Salem EY, El- Nahas HE.(2009):** "Effect of exercise on ventilatory function in welders". EJB, (3), No1: 67-72.
12. **Fernando J., Robert L., Kevin R., Cown M., Jonathan B., and Wald J.(1999):** "Respiratory response during arm elevation in isolated diaphragm weakness". Am. J. Respir. Crit. Care Med. 160(2):480-486.
13. **Garrido P. C., Díez J. M., Gutiérrez J. R., Centeno A. M., Vázquez E. G., Miguel Á. G., Carballo M. G.and García R. J.(**

Corresponding Author: Dr. Gohar Mohammed Gohar

2006): "Negative impact of chronic obstructive pulmonary disease on thehealth-related quality of life of patients. Results of the EPIDEPOC study". Health and Quality of Life Outcomes, 4:31.

14. **Gibson G.J. , Geddes D.M., Costable U., Sterk P.J. and Corrin B.(2003):"**Chronic obstructive pulmonary disease, Epidemiology and natural history". Respiratory Medicine ,3rd ed..vol.$_2$,p.p:1121-1126.
15. **Gigliotti, F, Coli C, Bianchi R, et al.(2005):** "Arm exercise and hyperinflation in patients with COPD. Effect of arm training". Chest; 18: 125-132.
16. **Guell R, Casan P, Belda J, Sangenis M, Morante F, Guyatt GH, Sanchis J.(2000):** "Long-term effects of outpatient rehabilitation of COPD: a randomized trial". Chest;117:976–983.
17. **Hamilton AL, Killian KJ, Summers E, Jones NL(1996):** "Symptom intensity and subjective limitation to exercise in patients with cardiorespiratory disorders". Chest;110:1255–1263.
18. **Holland AE, Hill CJ, Nehez E, Ntoumenopoulos G.(2004):** "Does unsupported upper limb exercise training improve symptoms and quality of life for patients with chronic obstructive pulmonary disease?". J Cardiopulm Rehabil; 24:422-7
19. **Lagorio S., Forastiere F., Pistelli R., Iavarone I., Michelozzi P., Fano V., Marconi A., Ziemacki G., and Ostro B. D.(2006):"**Air pollution and lung function among susceptible adult subjects: a panel study". Environ. Health.; 5: 11(4):116-122.
20. **Mador M. J. and Bozkanat E.(2001):"**Skeletal muscle dysfunction in chronic obstructive pulmonary disease", Respir Res.; 2(4): 216–224.
21. **Martinez F. J., Courser J.I., Celli. B.R.(2003):** "Respiratory response to arm elevation in patients with chronic airflow obstruction". Am. Rev. Resp. Dis., 143(3): 476-480, 1991
22. **Martinez F. J., Courser J.I., Celli. B.R.(2003):** "Respiratory response to arm elevation in patients with chronic airflow obstruction". Am. Rev. Resp. Dis., 143(3): 476-480, 1991
23. **Mckeough Z. J., Alison J. A., Bye P.T(2003).** "Arm exercise capacity and dyspnea rating in subjects with chronic obstructive pulmonary disease". Journal of Cardiopulmonary Rehabilitation, 23(3): 218-225.
24. **Owens G., Thompson F., Sciurba F., Robertson R., Metz K., Volmer R.(1988):** "Comparison of arm and

leg ergometry in patients with moderate chronic obstructive lung disease." Thorax;43(11):911-915,

25. **Parmet Sharon; Cassio Lynm; Richard M. Glass.(2003)** " Chronic Obstructive Pulmonary Disease" JAMA:2003;290(17):2362
26. **Pauwels RA, Buist AS, Calverley PM. (2001)**. "Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease": NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD) Workshop summary. Am J Respir Crit Care Med. 163: 1256-1276
27. **Ruppel G. L.(2003):"**Spirometery and Related Testes". Manual of Pulmonary Function Testing. Ch(2). 8th ed. Philadelphia, PA, USA:Pp.40-42.
28. **Sherniack N.S.; Altos M.D. and Homma I.(1999):**"Rehabilitation of patient with respiratory disease". 1st ed. McGraw-Hill Company, New York: 105-308.
29. **Talavera, M., Kumar D., and Casaburi R. (1998):** The ABCs Of PFTs (Pulmonary function tests provide key physiologic clues to disease processes, yet they remain underused in primary care setting). The journal of Respiratory Care Practitioners, 10(3):31-37.
30. **Velloso. M., Srella S.C, Cendon S., Sliva A. C., Jardian J. R.(2003):** Metabolic and ventilatory parameters of four activities of daily living accomplished with arms in COPD Patients. Chest., 123(4): 1047-1053,

Corresponding Author: Dr. Gohar Mohammed Gohar