Research Article

A Comparative Study on Effect of Moderate and heavy Intensity Exercise Prescription in Moderate COPD Patients on Haemodynamics and Functional Capacity

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Abstract Patients with COPD have reduced functional capacity due to deconditioning. Various studies have found that endurance exercise training is single most important aspect of rehabilitation for patients with chronic pulmonary disease. However, there are conflicting views about the intensity for exercise prescription in stable COPD patients. The optimal specific exercise prescription guidelines in terms of intensity prescription have not been well documented. The purpose of this study was to compare the effect of two training intensities in stable COPD patients, which would help in formulating a comfortable and efficient exercise program in this population. 60 male subjects with moderate COPD were selected through purposive sampling and randomly allocated into two groups, group A and group B, each group having 30 subjects (n=30). Group A subjects were trained with moderate intensity and Group B subjects with heavy intensity exercise. Subjects were trained with the prescribed intensity exercise for respective groups for 10 min per day, 4 times a week for 4 weeks of duration. Outcome of interest include Resting Heart rate, Respiratory rate, Distance covered in 6-min walk test, % predicted FEV1 value, % predicted FEV1/FVC ratio. Data were analysed using paired and unpaired t test. Group B showed significant improvement in RHR, RR. Improvement is found in both groups for 6-MWD, whereas group B subjects showed more significant improvement. However, there was no improvement found in FEV1 and FEV1/FVC ratio in either group. The result of this study revealed that heavy intensity exercise training provides benefits to patients with moderate COPD than moderate intensity exercise training in terms of improvements in functional status if done with permissible interval training during the training. There was 18% of improvement in 6-MWD in group B.
Keywords: Stable COPD, Moderate intensity exercise, Heavy intensity exercise, interval training, 6-MWD.

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a preventable and treatable disease with some significant extrapulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases[1]. COPD will usually worsen with time, especially if untreated. The WHO estimates that COPD causes 4.7 million deaths annually, making the condition the fifth leading cause of global mortality.[2] A study published by World Bank / WHO reported COPD is likely to rise from being 12th most burdensome disease in 1990 to 5th in 2020.[3] In the Indian scenario the prevalence rates of COPD in males is reported as 2.12% to 9.4% and that for females is 1.33% to 4.9% in the studies from north India while the prevalence rates of COPD from South India for males is 1.4% to 4.08% and that for females is 2.55% to 2.7%. The Medians are 5% for male and 2.7% for females. Total disease burden was calculated as 8.15 and 4.21 millions for male and females respectively. Smoker: non-smoker prevalence ratios varied from 1.6 to 10.2. Burden of smoking associated COPD was estimated at 6.7 millions in the male population[4]. There is a significant

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burden of COPD as a disease in the community with overall prevalence of 6.85% in South India.[5] The Global Initiative for Chronic Obstructive Lung Disease, 2002 has proposed universal guidelines for the classification of COPD on the basis of both spirometry and clinical symptoms to define stage of disease.[6] It has been found that many patients with COPD entering a rehabilitation program are deconditioned. Several mechanisms have been proposed for the exercise intolerance seen in COPD like ventilatory limitation, gas exchange limitation, cardiac dysfunction, skeletal muscle dysfunction.[7] Exercise has been found to be helpful in multiple ways in these patients. The benefits of exercise may be both physiological and psychological. The primary goal of rehabilitation is to restore the patient to the highest possible level of independent function. Various studies have proposed different mechanisms for the exercise benefits. Endurance Exercise Training (EXT) is singly the most important aspect of rehabilitation for patients with chronic pulmonary disease. Pulmonary rehabilitation must recognize the importance of achieving clinically meaningful responses (e.g. increased 6-min walk distance of 54 m) as well as the need for maintenance exercise program to sustain the benefits[8]. Intensity of exercise is an essential component of the prescription because of its importance in eliciting the acute while maintaining the chronic effects of exercise. The purpose of this study was to compare the effect of two training intensities in stable COPD patients, which would help in formulating a comfortable and efficient exercise program in this population.

METHOD

A pre post experimental study was conducted in an outpatient clinic in Pune, Maharashtra, India. Subjects were referred by their healthcare providers. Individuals were included if they were medically diagnosed as stable moderate COPD by physician, all male patients to maintain homogeneity in sample as females have less exercise tolerance capacity compared to their male counterpart, FEV1 less than 80% to 50% predicted value (moderate COPD)[6], FEV1/FVC ratio less than 70% predicted. Exclusion criteria included patients having specific cardiac involvement, lower limb musculoskeletal problems, acute systemic infection, acute exacerbation of COPD, recent systemic or pulmonary embolus, emotional distress like psychosis, neuromuscular or rheumatoid disorder. Patients with moderate COPD coming on Out-Patient Department of Medicine (OPD) basis for treatment were included in the study. Total 162 patients were screened during the period of 8 months and out of them 73 subjects were selected through purposive sampling for the study based on the inclusion and exclusion criteria and after ruling out the contraindications. 60 patients out of 73 were randomly allocated into two groups, group A and group B, each group having 30 patients. All the subjects participating in the study were explained about the details of apparatus and test protocols and informed consent were taken prior to undergoing the procedure. Detailed clinical examination was done, proper history was taken and all the contraindications were again ruled out for reassurance before enrolling the patient into the study. Physician consent was taken to ruled out the cardiac involvement in the included patients. Sixty male patients who were included in the study were trained with prescribed intensities for respective groups, group A was assigned with moderate intensity exercise protocol while group B with heavy intensity exercise protocol, 4 times a week at the physiotherapy department. The training was followed for 4 weeks of duration under the supervision of the investigator. All the emergency arrangements were done before the subject starts the training session. Arrangements such as oxygen therapy, defibrillator, emergency drugs and all the arrangements to shift the subject from OPD to ICU were done.

Data analysis

Statistical analysis including mean, standard deviation, and standard error were calculated for all measurements. Data was analyzed by using paired‘t’ test and unpaired‘t’ test. In between group (Group A and Group B comparison) significance was calculated by using unpaired‘t’ test and within the group (pre and post training comparison of Group A and B) significance was calculated by using paired ‘t’ test to compare the homodynamic, Lung function and Functional status changes in patients with COPD.

RESULTS

Table 1: Comparison of Resting Heart Rate Within and Inbetween Group A and Group B

Outcome	Group	Training	Mean±SD	Paired ‘t’ value	Significance p value	Mean difference	Unpaired ‘t’ value	Significance p value
Resting Heart Rate	A	Pre	82.6±9.02	1.006	0.3226	0.96±5.26	4.618	<0.0001
		Post	81.63±7.08					
	B	Pre	89.53±2.66	8.424	<0.0001	6.73±4.37		
		Post	82.8±3.66					

As shown in table 1, there was no significant statistical difference (p 0.3226) in the resting heart rate, post training (mean 81.63 ± 7.08) and pre training (mean 82.6 ± 9.02), after the moderate intensity exercise training in group A. However, there was significant statistical difference (p < 0.0001) in the resting heart rate, post training (mean 82.8 ± 3.66) and pre training (mean 89.53 ± 2.66), after the heavy intensity exercise training in group B. When inbetween group comparison was done for resting heart rate mean difference of Group A (mean 0.96 ± 5.26) and Group B (mean 6.73 ± 4.37), as shown in table, there was significant reduction in RHR was found (p<0.0001) in group B patients.

Table 2: Comparison of Respiratory Rate Within and Inbetween Group A and Group B

Outcome	Group	Training	Mean±SD	Paired 't' value	Significance p value	Mean difference	Unpaired 't' value	Significance p value
Respiratory Rate	A	Pre	19.6±2.44	1.006	0.3227	0.53±2.35	7.142	<0.0001
		Post	19.43±2.44					
	B	Pre	20.73±2.04	12.665	<0.0001	4.53±1.96		
		Post	16.2±1.68					

As shown in table 2, there was no significant statistical difference (p 0.3227) was seen in the respiratory rate, post training (mean 19.43 ± 2.44) and pre training (mean 19.6 ±2.44), after the moderate intensity exercise training in group A. However, there was significant statistical difference (p < 0.0001) in the respiratory rate, post training (mean 16.2 ± 1.68) and pre training (mean 20.73 ± 2.04), after the heavy intensity exercise training in group B. When in between group comparison was done for respiratory rate mean difference of Group A (mean 0.53 ± 2.53) and Group B (mean 4.53 ± 1.96), as shown in table, there was significant reduction in respiratory rate was found (p<0.0001) in group B patients

Table 3: Comparison of 6-Min Walk Distance Within and Inbetween Group A and Group B

Outcome	Group	Training	Mean±SD	Paired 't' value	Significance p value	Mean difference	Unpaired 't' value	Significance p value
6-min Walk Distance	A	Pre	338.86 ±27.05					
		Post	365.73 ±27.54	41.566	<0.0001	26.86±3.54		
	B	Pre	348.36 ±51.69				15.215	<0.0001
		Post	411.63 ±58.05	27.467	<0.0001	63.26±12.61		

As shown in table 3, when compared the distance covered in 6-min walked test, post training (mean 365.73 ± 27.54) to pre training (mean 338.86 ± 27.05) in moderate COPD patients, significant statistical difference (p < 0.0001) was found in Group A. When distance covered in 6-min walked compared, post training (mean 411.63 ± 58.05) to pre training (mean 348.36±51.69) in moderate COPD patients, significant statistical difference (p < 0.0001) was found in the Group B also. When inbetween group comparison was done for six min walk distance mean difference of Group A (mean 26.86±3.54) and Group B (mean 63.26 ± 12.61), as shown in table, there was significant difference was found (p<0.0001) in group B patients. The percentage of improvement in 6-MWD in group B was 18% that of group A of 7%.

Table 4: Comparison of FEV1 Within and Inbetween Group A and Group B

Outcome	Group	Training	Mean±SD	Paired 't' value	Significance p value	Mean difference	Unpaired 't' value	Significance p value
FEV1	A	Pre	66.9±6.47	1.739	0.0926	1.13±3.56	0.9970	0.3229
		Post	68.03±6.32					
	B	Pre	67.26±5.27	0.2116	0.8332	0.3±2.86		
		Post	67.56±5.69					

When the FEV1 values were compared in the moderate COPD patients as shown in table 4, post training (mean 68.03 ± 6.32) and pre training (mean 66.9 ± 6.47), there was no significant statistical difference (p 0.0926) was found after the moderate intensity exercise training in group A subjects. Also, when the FEV1 values were compared, post training (mean 67.56 ± 5.69) and pre training (mean 67.26 ± 5.27), there was no significant statistical difference (p 0.8332) was found after the heavy intensity exercise training in group B subjects. When in between group comparison was done for FEV1 mean difference of Group A (mean 1.13 ± 3.56) and Group B (mean 0.03 ± 2.86), as shown in table, there was no significant difference was found (p 0.3229) in both the groups.

Table 5: Comparison of FEV1/FVC Ratio Within and Inbetween Groups A and B

Outcome	Group	Training	Mean±SD	Paired 't' value	Significance p value	Mean difference	Unpaired 't' value	Significance p value
FEV1/FVC Ratio	A	Pre	62.33±4.99					
		Post	62.36±5.34	0.1079	0.9148	0.03±1.69		
		Pre	60.93±5.57				0.1812	0.8568
	B	Post	60.86±6.00	0.1458	0.8851	0.06±2.50		

After comparing the FEV1/FVC ratio values of post training (mean 62.36 ±5.34) and pre training (mean 62.33 ± 4.99), as shown in table 5, there was no significant statistical difference (p 0.9148) was found with moderate intensity exercise training in group A subjects with moderate COPD. Also after comparing the FEV1/FVC ratio values of post training (mean 60.86 ± 6.00) and pre training (mean 60.93 ± 5.57), as shown in table, there was no significant statistical difference (p 0.8851) was found with heavy intensity exercise training in group B subjects with moderate COPD. When inbetween group comparison was done for FEV1/FVC ratio mean difference of Group A (mean 0.03 ± 1.69) and Group B (mean 0.06 ± 2.50), as shown in table, there was no significant difference was found (p 0.8568) in either group.

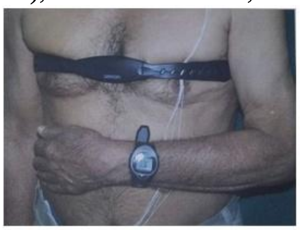

Figure 1

Figure 2

Figure 3

Legend

Figure 1: Subject with Heart Rate Monitor and Chest Trap; **Figure 2:** Subject Performing Pulmonary Function Test; **Figure 3:** Subject Performing Priscribed Intensity Exercise on Treadmill under Supervision.

DISCUSSION

The present study was designed to investigate the effect of moderate intensity exercise and heavy intensity exercise prescription in stable moderate COPD patients. There was statistical significant reduction change was seen in the resting heart rate values for group B patients with heavy intensity training in pre and post training values compared to group A patient's. The resting heart rate valves showed significant reduction in post training from the pre training value. In COPD patients with moderate intensity endurance training, individuals resting heart rate decreases 1 beat / week.[12] The actual mechanism responsible for this is not entirely known. There is a decrease in sympathetic drive, with decreasing levels of norepinephrine and epinephrine; a decrease in atrial rate secondary to biochemical changes in the muscle and levels of acetylcholine, norepinephrine, and epinephrine in the atria; and an apparent increase in parasympathetic (vagal) tone secondary to decreased sympathetic tone.[13,14] The significant reduction in heart rate in heavy intensity could be attributed to increase in plasma volume following heavy intensity exercise which will lead to increase in venous return thus leading to increase in stroke volume and thereby decreasing the heart rate to maintain the constant cardiac output. Plasma normally constitutes about 55% to 60% of total blood volume and can increase by 10% or more with endurance training. This increase in plasma volume decreases the blood viscosity and thus increase the oxygen transport.[15] An increase in blood volume and hemoglobin may occur which facilitates the oxygen delivery capacity of the system.[14] Resting heart rate was reduced when patient was exercising at 60% VO_{2max} which is correlated as heavy intensity exercise on RPE and HRR.[11] In response to constant work rate, the kinetics of O_2 uptake, CO_2 production, VE and heart rate are reduced.[16] There was statistical significant reduction change was seen in the respiratory rate values for group B patients with heavy intensity training in pre and post training values compared to group A patient's. The respiratory rate valves showed significant reduction in post training from the pre training value. COPD patients have an increased physiologic dead space and breath more to achieve the same level of alveolar ventilation. COPD patients have reduced expiratory flow rates at all levels of ventilation. These patients compensates for flow difficulties by increasing breathing frequency and decreasing tidal volume compared to normal subjects.[17] During exercise, inspiratory movements are assisted by accessory inspiratory muscles, which include the sternocleidomastoid, scalene, and trapezius muscles. These muscles act to lift the ribs and clavicles vertically and transversely allowing for larger increases in tidal volume during exercise,[16] this increase in tidal volume helps in reducing the dead space which is resulted in the reduction of the frequency i.e. rate of breathing and increase in the depth of breathing. Airway narrowing hinders ventilation by trapping air in the bronchioles and alveoli; in essence, the disease increases pulmonary physiologic dead space. The obstruction also increases resistance to airflow (chiefly in expiration), hinders normal gas exchange, and reduces exercise performance by increasing the energy cost of breathing.[19] Improved exercise tolerance may reflect changes in breathing pattern, specifically, increased tidal volume and reduced respiratory rate.[15] The significant reduction in respiratory rate after heavy intensity exercise training may be explained by increased tidal volumes following training. Increased tidal volumes may reduce the physiological dead space, and the minute ventilation can be maintained with a slower respiratory rate. Moderate intensity exercise might not be sufficient enough to induce these changes in the alveolar ventilation. This could possibly explain why the respiratory adaptation was seen only in the heavy intensity group. The self-paced 6MWT assesses the Submaximal level of functional capacity. Most patients do not achieve maximal exercise capacity during the 6MWT; instead, they choose their own intensity of exercise and are allowed to stop and rest during the test. However, because most activities of daily living are performed at Submaximal levels of exertion, the 6MWD may better reflect the functional exercise level for daily physical activities[20] (ATS statement: 2002). The functional capacity was calculated by 6-min walk test as it is a quick measure of functional status in elderly and diseased individuals.[21] Pulmonary diseases typically results in dyspnea or shortness of breath with exertion. As a result of this dyspnea, pulmonary patients limit their physical activity and deconditioning result. Pulmonary patients experience even greater dyspnea with even lower levels of physical exertion. Exercise has been shown to be an effective intervention that can break this vicious cycle and prevent disability and functional impairments.[22] Much of the disability associated COPD results from spiral of progressive physical deconditioning from a sedentary lifestyle (as patient attempt to avoid dyspnea) and is not just the direct effect of the disease. Frequently, peripheral and respiratory muscle weakness contribute to the COPD patients poor exercise performance and physiologic incapacity.[23] Poor exercise tolerance and early onset of lactate accumulation in COPD patients do not always link closely to limitation in pulmonary ventilation and gas exchange in exercise. Rather, peripheral skeletal muscle performance deteriorates in COPD as reflected by, 1) decreased muscle mass and strength and 2) reduced skeletal muscle oxidative capacity from a marked decrease in type I and increases in type IIb muscle fiber proportions and reduced mitochondrial enzyme activities. Loss of peripheral function possibly results from detraining with sedentary lifestyle.[21] With aerobic exercise, these patients improve the collaterization of peripheral capillaries so as to improve blood flow to working muscles and increase nitric oxide production in the blood vessels, which mediates endothelium-dependent relaxation (Belardinelli and Perna, 2002) and this effect is correlated with functional capacity.[24] Regular endurance exercise increases oxidative enzymes in the working muscles and is associated with a shift from type II to type I fibers (Hambrecht et. al., 1997). Endurance training is associated with increased skeletal muscle activity and recruitment of slow-twitch fibers[25,26] (Gosselin et.al.,2003). Gerard J. Criner, et.al. (1999)[10] reported in his study that there was a trend toward a higher 6-min walk distance and total exercise time on maximal exercise test was significantly longer compared with baseline values. Frits M. E. Franssen et.al. (2004)[9] concluded in his study that there is improvements in exercise performance and muscle function in patients with COPD. Pulmonary function for FEV1 and FEV1/FVC ratio in both the groups when compared showed no significant change. Previous studies advocate that there will be no change in FEV1 and FEV1/FVC in COPD patients even with longer duration of exercise because of the structural change. Gerard J. Criner, et.al. (1999) reported in his study that pulmonary function tests remained unchanged compared with baseline data.[10] Regular exercise does not improve pulmonary function of individual with emphysema.[18] In the COPD patients, lung functions does not tend to improve with training although endurance training may delay the deterioration of pulmonary function and maximal oxygen consumption and work capacity may improve.[25] In COPD patients, inflammation of the bronchial wall is typically present through the course of the disease, with increasing inflammation during exacerbation. In addition to destruction of the lung parenchyma in emphysema, small airways are affected (obstructive bronchiolitis). Chronic inflammation leads to the remodeling and narrowing of small airways.[26] An obstructive component in COPD patients generally relates to problems in exhalation airflow and characteristic pattern of obstruction such as in the FEV1.[27]

CONCLUSION

After comparing the results, we can conclude that there was significant reduction was found in resting heart rate and respiratory rate in stable moderate COPD exercising at heavy intensity than patients exercising at moderate intensity. Also, there was significant improvement was found in functional capacity of the moderate COPD patients with both moderate and heavy intensity exercise training but there was more significant improvement was seen with the heavy intensity exercise training. Whereas no was change was found in FEV1 and FEV1/FVC ratio after either moderate or heavy intensity exercise training. Heavy intensity exercise training provides more benefits to patients with moderate COPD than moderate intensity exercise training in terms of improvements in functional status if done with permisiable interval during the training**.**

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