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Efficacy of Resistance Training Versus Endurance Training on QOL and Exercise Capacity in Subjects with COPD

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ABSTRACT

Background Objective: Skeletal muscle dysfunction contributes to exercise limitation in patients with COPD. Resistance Training increases muscle strength and muscle mass, but there is an on-going debate on the additional effect concerning the Exercise Capacity. The purpose of the study is to compare the effects of different exercise modalities in subjects with COPD including Resistance Training versus Endurance Training on Quality of Life and Exercise Capacity.

Methods: Prospective study design was 64 subjects with mean age of 50 years having a clinical diagnosis of COPD were randomly allocated into two groups. Group A received Resistance Training and Group B received Endurance Training for about 5 sessions a week for 8 weeks. The outcomes of this Resistance Training and Endurance Training were measured by SF-36 Questionnaire and 6-Minute Walk Test.

Result: Independent't'test was used to compare the mean significance difference between continuous variables. Paired't'test was used to assess the Statistical significance difference in pre and post test scores. Statistical analysis of this data revealed that within group comparison both groups showed significant improvement in all parameters whereas in between group's comparison ET showed better improvement compared to RT.

Conclusion: The present study was concluded that after 8 weeks of Intervention of both RT and ET showed significant improvement in SF-36 Questionnaire and Exercise Capacity, However ET showed more improvement when compared to RT. Hence, we conclude that ET is a Suitable Adjunct in pulmonary rehabilitation in subjects with COPD.

Keywords: COPD, Resistance training (RT), Endurance training (ET), QOL, Conventional Physiotherapy

INTRODUCTION

Chronic Obstructive Pulmonary Disease is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow obstruction which is due to airway or alveolar dysfunction [(1)].Chronic Obstructive Pulmonary Disease (COPD) is the third leading cause of death and a major cause of mortality around the world [(2)].Based on Burden of Obstructive Lung Disease (BOLD) and other large scale epidemiological studies, it was estimated that the number of COPD cases was 384 million, with a global prevalence of 11.7% (8.4%-15.0%)[(3)].The prevalence of COPD in India was reported to be between 6.6 to 7.7 %[(4)]

COPD caused by chronic exposure of genetically susceptible individuals to environmental factors.Tobacco smoke, biomass fuel exposure,

passive smoking, exposure to dust and fumes, history of repeated lower respiratory tract infections during childhood, history of pulmonary tuberculosis, chronic asthma, Alpha-1 antitrypsin deficiency, poor nourishment, poor socioeconomic status [5]. COPD is a complex syndrome comprised of airway inflammation, mucociliary dysfunction and consequent airway structural changes [6, 7]. It was characterized by chronic inflammation of the airways, lung tissue and pulmonary blood vessels as a result of exposure to inhaled irritants such as passive smoke [8, 9].The inhaled irritants cause inflammatory cells such as neutrophils, CD8+ T-lymphocytes, B cells and macrophages to accumulate. When these cells are activated they initiate an inflammatory cascade that triggers the release of inflammatory mediators such as Tumour Necrosis Factor alpha (TNF-α), Interferon gamma (IFN-$_\gamma$), matrix –metalloproteinase's (MMP-6, MMP-9), C-reactive protein (CPR), interleukins (IL-1. IL-6, IL-8) and fibrinogen[10].The chronic inflammation is present from the outset of the disease and leads to several structural changes in the lung which further continues airflow limitation [10].Patients may not have any symptoms or may present with minimal symptoms during the early stages of COPD typical clinical features of COPD includes breathlessness, Chronic cough may be intermittent and may be unproductive, regular sputum production, frequent winter bronchitis, wheeze are present in the later stages[11]. Important symptoms include dysponea, fatigue, and running nose, changes in sputum color or amount of sputum and cough [12]. Other symptoms which should be considered in COPD patients include – hyper inflated chest, wheeze or quiet breath sounds, purse lip breathing, use of accessory muscles, paradoxical movement of lower ribs, peripheral oedema, and cyanosis [12].Exercise intolerance is a chief complaint of patients with COPD. Skeletal muscle dysfunction is a common extra pulmonary manifestation of COPD. Muscle changes observed in patients with COPD include reductions in type I fibers, atrophy of type I and II fibers, reduced capillarity, and altered metabolic enzyme levels [13].The chronic airflow limitation is caused due to mixture of small airway disease (obstructive bronchiolitis) and parenchymal destruction (emphysema) which is differing from one person to another. The reduction in maximum expiratory flow rate and slow forced emptying of lung are the most common problems are seen in COPD which leads to dyspnea and reduction in exercise tolerance [14]. Impaired Exercise Capacity, Dyspnea and Health Related Quality of Life is common complaints. Most common exercise limiting factor in COPD is peripheral muscle dysfunction that is characterized by the atrophic muscles and reduced fatigue resistance due to morphological and metabolic alterations in leg and diaphragm muscles. Avoidance of activity as a strategy to limit the experience of dyspnea leads to a sedentary lifestyle and exercise intolerance [14].Respiratory rehabilitation with physical exercise improves exercise capacity muscle strength and HRQL (Health Related Quality of Life) although physical exercise is a mandatory component of respiratory rehabilitation programme there is an ongoing debate about what type of exercise at which intensity subjects should perform remain unsolved. There are substantial variations in exercise protocols used in practice as well as in clinical-trails[14].Skeletal muscle dysfunction is an important consequence of Chronic Obstructive Pulmonary Disease (COPD) and contributes to disease morbidity and possibility also mortality. To prevent muscle depletion International guidelines recommend Resistance Training as part of Pulmonary Rehabilitation for COPD [15].

Pulmonary Rehabilitation in patients with COPD is known to improve exercise capacity and muscle strength and reduce the number of days in hospital and is today a standard of COPD treatment [16]. Supervised Endurance Training (ET) that includes whole body exercise such as cycling and walking has traditionally been the main component of PR Pulmonary Rehabilitation. So Resistance Training verses Endurance Training alone has been reviewed previously where only small differences between these two training strategies were found [17].Exercise Training has been shown to be an effective means of reversing this functional impairment and improving muscle strength by StrengthTraining/Resistance Training and Endurance Training. Resistance Training is an exercise modality in which small muscles groups are trained by repetitively lifting heavy weights. Resistance Training enhanced peripheral muscle force, muscle endurance and whole body endurance in COPD subjects [10, 11]. Lower extremity aerobic training consistently results in an

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increase in exercise endurance in patients with COPD without evidence of adverse outcome [12]. The mechanism by which exercise improves endurance remains unclear, although muscle biopsy studies showing increased skeletal muscle oxidative capacity (capillarity, aerobic enzyme concentration, mitochondrial density) support for a true training effect[13]. How-ever the two previous reviews did not systematically grade the quality of the evidence of the meta-analysis performed and did not investigate potential harms. The effects of Endurance Training and strength training (exercise capacity) in Chronic Obstructive Pulmonary Disease (COPD) patients have been studied thoroughly, while Resistance Training has been rarely evaluated. This study investigated the effects of Resistance Training (RT) in comparison with Endurance Training (ET) in subjects with COPD [17].

MATERIALS AND METHODS

Study Design: Prospective Study

Ethical Clearance and Informed Consent: The Study protocol was approved by the Ethical Committee of GSL Medical College Rajamahendravaram (Annexure-I); the principal investigator explained the purpose of the study and given the patient information sheet. The participants were requested to provide their consent to participation in the study (Annexure-II). All the participants signed the informed consent and the rights of the included participants have been secured.

Study Population: Subjects clinically diagnosed with Chronic Obstructive Pulmonary Disease (COPD) by Pulmonologist

Study Setting: The study was conducted at Department of Respiratory Medicine, GSL General Hospital, Rajamahendravaram, Andhra Pradesh, India.

Study Duration: The study was conducted during the period between June 2019 and June 2020.

Sampling Method: Simple Random Sampling

Intervention Duration: 5 sessions a week for 8 weeks includes Resistance Training with Conventional Physiotherapy and Endurance Training with Conventional Physiotherapy.

Sample size (n): A total number of 76 subjects with COPD were screened in that 64 subjects were recruited who met the inclusion criteria and willing to participate in the study. The Recruited participants were explained the purpose and relevance of the study. Those willing to volunteer were included in the study after obtaining informed consent. All the eligible participants were consecutively randomized in to 2 groups, in which 33 patients in Group A and 31 in Group B

MATERIALS USED:

Consent form, Data collection, Measuring tape, Dumbbells, Tread mill, Cycle ergometer, Inch tape, multiple exerciser, Pulse Oximeter, Stethoscope, Sphygmomanometer, SF-36 Questionnaire

INCLUSION CRITERIA

- COPD patient who is stable and diagnosed by Pulmonologist
- Patients between the age 40-60 years.
- Ambulatory patients.
- Patients who can be able to climb and do cycling are included.
- Patients who are not undergone any previous rehabilitation.
- Patients who are on COPD medication(Bronchodilators)

EXCLUSION CRITERIA

- COPD with acute exacerbations.
- Patients with coronary artery disease.
- Hypertension / cor pulmonale.
- Neuro-musculo skeletal disorder.
- Patients who are on oral steroids.

STUDY PROCEDURE: Total of 64 subjects after fulfilled the inclusion criteria was taken by simple random sampling. All the subjects were explained about the condition and mode of assessment and written informed consent were obtained from them and pretest is done and divided into 2 groups A and B resistance/strength training group and endurance exercise training group respectively and subjects in both groups were scheduled to attend exercise session

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5 days per week for 8 weeks. During the treatment intervention they were given inhaled bronchodilators and most of them were given either short or long-acting anticholinergics. During training program all the patients were allowed to continue their pharmacological therapy, counseling about smoking cessation, food habits and conventional physiotherapy was given commonly.

Pretest for exercise tolerance is done by six minute walk test before and strengthening exercises (leg flexion and leg extension) intervention and maximal heart rate was measured by incremental cycle ergometer for both groups

GROUP A-Resistance training was given 5 days per week. It includes different exercises, which were performed with the following weight lifting procedures; chest pull, butterfly, neck press, leg flexion, leg extension. The weight lifting exercises will perform with gymnastic apparatus. The subjects will perform 4 series of 6 to 8 repetitions for each of the exercise included in this program at a workload of 70 to 80% of the 1RM. This test was repeated each 2 weeks for new adjustment of the workload in each session; they will have a warm up period of 15 minutes at 20% of the short time maximum exercise capacity. The subjects were instructed to exercise for 14 minutes at high intensity intervals of 20 seconds at 50% and at low intensity intervals of 40 seconds at 20% of the short time maximum exercise capacity, i.e. with a work/recovery ratio of 1:2.Then they have a slowdown period of three minutes before completion of the training session. Pulse oxymeter will be used and oxygen supplementation will be provided if needed. Resistance training also includes different exercises, which were performed with the following weight lifting procedures, leg flexion, leg extension. The weight lifting exercises will perform with gymnastic apparatus. The patients will perform 4 series of 6 to 8 repetitions for each of the exercise included in this program at a workload of 70 to 80% of the 1RM. This test was repeated each 2 weeks for new adjustment of the workload [(17)].

If subjects cannot sustain exercise intensity because the heart rate exceeds the limits determined after exercise testing or because of perceived dysponea or leg fatigue, rest should be given for one minute and then resume exercise. If they have to rest more than twice per session, we will lower the workload from 50% of the short time maximum exercise capacity by steps of 10% while the length of intervals remains constant. We will increase the training load again as possible for the subject [(17)].In turn, if subject consider the workload to be too low, we will increase workload of the high intensity interval by steps of 10% until subject considers the workload was proper while the length of intervals remains constant.

GROUP B-Endurance training was given for 5 days per a week it consisted of ergometer cycling and treadmill walking. The initial intensity for cycling was set at 30%Wpeak for 10mins. Increases in workload were based upon symptom scores, trying to achieve a workload of 75% for 25mins in week 8. Treadmill walking speed was set at 60% of the average speed obtained from the 6MWD (6MWDpeak) for 10mins in the first week and was increased to 25mins in week 8. A Borg scale of 5–6 for dyspnea or fatigue was set as a target. Subjects assigned to this group will perform a steep ramp test to determine the short time muscular maximum exercise capacity. The target workload for this group will be >=70% of the maximum exercise capacity expressed in watts and heart rate achieved during the incremental cycle ergometer test [(22)]. Subjects who usually not able to perform high intensity continuous exercise from the beginning and have to adapt to physical exercise. We will increase training load as soon as possible to>=70% of the maximum exercise or as high as each individual tolerates. In each session, subjects will have a warm-up period of three minutes at 20% of maximum exercise capacity, increase the exercise intensity within two minutes to the target intensity, the subjects were instructed to exercise for 14 minutes at high intensity and then have a decreasing period of three minutes (gradual decrease from 70% to 0%).Pulse oxymeter will be used to supervise subject during exercise. If oxygen saturation falls below 90%, oxygen supplementation will be provided to maintain >90 %[(21,23)].

If subjects cannot sustain the workload because of perceived dyspnea or leg fatigue or because the heart rate exceeds the limits determined during exercise testing, we will let subject rest for one minute and then resume exercise. If they have to rest more than twice per session, we lower the workload by steps of 10% of baseline maximum exercise capacity. In turn, if subject consider the workload to be too low or if patients do not reach their target heart rate at 70% of

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the maximum exercise capacity, the workload should increase by steps of 10% of maximum exercise capacity until they consider the workload to be proper or until the target heart rate is reached [24].

Conventional physiotherapy includes

1. Chest physiotherapy
2. Diaphragmatic breathing exercise
3. Incentive spirometry
4. Thoracic mobility exercises.

STATISTICAL ANALYSIS

All statistical analysis was done by using SPSS software version 21.0 and Microsoft Excel 2007. Descriptive Statistical data were presented in the form of mean +/- Standard deviation and Mean difference were calculated and presented.

BETWEEN THE GROUPS: Independent Student "t"- test was performed to assess the statistical significant difference in the mean values of between the groups for SF-36 Questionnaire and 6 Minute Walk Test.

WITH IN THE GROUPS: Paired Student "t"-test and was performed to assess the statistical significant difference in the mean values of between the groups for SF-36 Questionnaire and 6 Minute Walk Test

For all statistical analysis P-Value < 0.05 was considered as statistically significant with 95% confidence intervals.

RESULTS

The aim of the study was to find the efficacy of Resistance training versus Endurance training on Quality of Life and Exercise Capacity in COPD subjects.

The consort flow chart of the study showed the study organization in terms of subjects screening, random allocation and analysis following the intervention.

A total number of 76 subjects were screened for eligibility, in which 64 patients were recruited in to the study. All the subjects who met inclusion criteria were included in to the study had undergone a baseline assessment and these subjects were randomized in to two equal groups in which Group A consists of 33 patients and Group B consists of 31 patients

The results of this study were analyzed based on the outcome parameter, Exercise Capacity which includes SF-36 Questionnaire and 6 Minute Walk Test.

DISCUSSION

The aim of the study was to know the effectiveness of Resistance training versus Endurance training on Quality of Life and Exercise Capacity in COPD subjects. In this study 64 COPD subjects have been performed Resistance Training, and/or Endurance Training for 8 weeks program. The outcome parameters of this study are SF-36 questionnaire and 6min-walk test which is taken before and after the intervention. These parameters are used to measure the Quality of Life and Exercise Capacity. The results of the study showed statistically significant difference when comparing both the Resistance exercises and Endurance exercises along with conventional physiotherapy in subjects with COPD who received 8 weeks protocol. Exercise training was shown an effective therapy for exercise limitation in patients with COPD. Resistance training in COPD patients causes improvement in Quality of Life and observed improvement in Exercise Capacity after strengthening exercise, along with conventional physiotherapy ($p<0.05$).The whole-body resistance training program should be included in pulmonary rehabilitation therapy. The exercise prescription of 2–3 sets at 30–60% of 1-RM for 8–12 repetitions did not cause injuries and produced increases in muscle mass and strength. [17].Wen-hua Liao,et al. conducted a study on their systemic review and meta analysis on impact of Resistance training in subjects with COPD , they concluded that, there was an improvement in dysponea scale scores, skeletal muscle strength and lung function followed by resistance training [22].Bennie Westra,et al conducted a study on A systematic review and demonstrated that Quality of resistance training description in COPD trials, they concluded that results of their provided important information to guide the design of future Resistance Training interventions and clinical work in patients with COPD[23]. Endurance training was also showed improvement in Quality of Life and Exercise Capacity ($p<0.05$). The peripheral adaptation in skeletal muscle that occurs with endurance training was characterized by an increase in mitochondrial oxidative capacity and in muscle capillarization, and a transformation of type lIb muscle fiber to type lIa [24]. This is associated with smaller increases in muscle and blood lactic acid

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concentrations during exercise. In contrast, endurance training has a minimal impact on glycolytic enzyme activity [25, 26, 27].Walid kamal Abdel basset et al, conducted a study and demonstrated that Effect of 12-week endurance exercise on obese elderly patients with COPD: a randomized trial in their study they concluded that endurance exercise improves pulmonary functions and aerobic capacity in obese elderly patients with COPD. Endurance exercise should be recommended as an imperative element of respiratory rehabilitation among individuals with respiratory disease in elderly COPD patients [28].M. Jeffery Mador, et al, conducted a study on Effect of Respiratory Muscle Endurance Training in Patients with COPD Undergoing Pulmonary Rehabilitation. In their study they concluded that hyperpneic training, when added to a program of endurance training, significantly augments respiratory muscle endurance, but this improved endurance does not translate into additional improvements in Quality of Life or Exercise performance [29]. However, these changes did not translate into further improvement in exercise tolerance as measured in this study. It is possible that a longer duration of training would have produced a greater improvement in exercise capacity with the strength training than endurance training. Further studies are required to determine whether greater improvements in peripheral muscle function can be translated into a gain in exercise capacity by increasing the duration of the training sessions or by modifying the training movements to resemble activities relevant to the patients' daily living [29].Resistance exercise elicits a reduced cardio-respiratory response compared with endurance exercise. Resistance exercise demands a lower level of oxygen consumption and minute ventilation, and evokes less dyspnea. In clinical setting, this makes Resistance exercise an attractive and feasible option for individuals with advanced lung disease or comorbidities; as in patients with severe COPD, who may be unable to complete high-intensity endurance or strength training because of intolerable dyspnea. It may also be an option for training during disease exacerbations [30].In accordance with the literature on pulmonary rehabilitation, both training modalities examined in the present study resulted in significant improvements in functional exercise capacity measured by 6MWT and Quality of Life measured by SF 36 Questionnaire. The benefit of techniques in improving muscle strength (exercise capacity) and Quality of Life is level of evidence as demonstrated by the recent ATS official statement [31].The present study has also demonstrated to be safe since adverse outcomes were noted. Endurance Training in COPD patient causes improvement in Quality of Life and Exercise Capacity and also useful in patient with cardio vascular problems where by the use of Endurance Training there will be less cardio vascular stress than Resistance Training. The result of the present study showed that both groups showed statistically significant difference from pre to post intervention however Endurance Training group showed greater improvement than Resistance Training group.

CONCLUSION

After Eight weeks of Intervention both Resistance Training group and Endurance Training group were shown significant improvement in Quality of Life and Exercise Capacity among Chronic Obstructive Pulmonary Disease patients. But Resistance training group were unable to complete high-intensity strength training activities because of intolerable dyspnea. Endurance exercise was being recommended as an imperative element of Respiratory Rehabilitation among individuals in COPD so Endurance Training Group has shown greater percentage of improvement when compared to Resistance Training Group. Hence this study concluded that Endurance Training is a suitable adjunct to Conventional Physiotherapy in subjects with Chronic Obstructive Pulmonary Disease.

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TABLES

Table-1: Analysis of Mean scores of SF-36 (PCS) within the Group-A

		Mean	SD	P-Value	Inference
GROUP-A	PRE	44.17	3.9	0.0001*	Highly Significant
	POST	53.20	3.96		

Table-2: Analysis of Mean scores of SF-36 (PCS) within the Group-B

		Mean	SD	P-Value	Inference
GROUP-B	PRE	43.40	3.55	0.0001*	Highly Significant
	POST	57.00	4.47		

Table -3: Comparison of Mean scores of SF-36 (PCS) between the Groups-A&B

		Mean	SD	P-Value	Inference
Pre	Group A	44.17	3.9	0.4377	Non-significant
	Group B	43.40	3.55		
post	Group A	53.20	3.96	0.0001*	Significant
	Group B	57.00	4.47		

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Table -4: Analysis of Mean scores of SF-36 (MCS) within the Group-A

		Mean	SD	P-Value	Inference
GROUP-A	PRE	55.1	3.21	0.0001*	Highly Significant
	POST	58.13	3.25		

Table- 5: Analysis of Mean scores of SF-36 (MCS) within the Group-B

		Mean	SD	P-Value	Inference
GROUP-B	PRE	55.07	2.86	0.0001*	Highly Significant
	POST	60.03	3.43		

Table-6: Comparison of Mean scores of SF-36 (MCS) between the Groups-A&B

		Mean	SD	P-Value	Inference
Pre	Group A	55.10	3.21	0.9669	Non-significant
	Group B	55.07	2.86		
post	Group A	58.13	3.25	0.0003	Significant
	Group B	60.03	3.43		

Table-7: Analysis of Mean scores of 6MWT within the Group-A

		Mean	SD	P-Value	Inference
GROUP A	PRE	341.56	13.82	0.0005	Significant
	POST	362.06	14.15		

Table-8: Analyses of mean scores of 6MWT within the Group-B

		Mean	SD	P-Value	Inference
GROUP B	PRE	356.03	17.06	0.0001*	Highly Significant
	POST	379.77	19.94		

Table-9: Comparison of Mean scores of 6MWT test between the Groups-A&B

		Mean	SD	P-Value	Inference
PRE	Group A	341.567	13.82	0.0007	Non significant
	Group B	356.033	17.06		
POST	Group A	362.067	14.15	0.0002	Significant
	Group B	379.767	19.94		

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FIGURES

Figure-1: Analysis of mean scores of SF-36 (PCS) within the Group-A

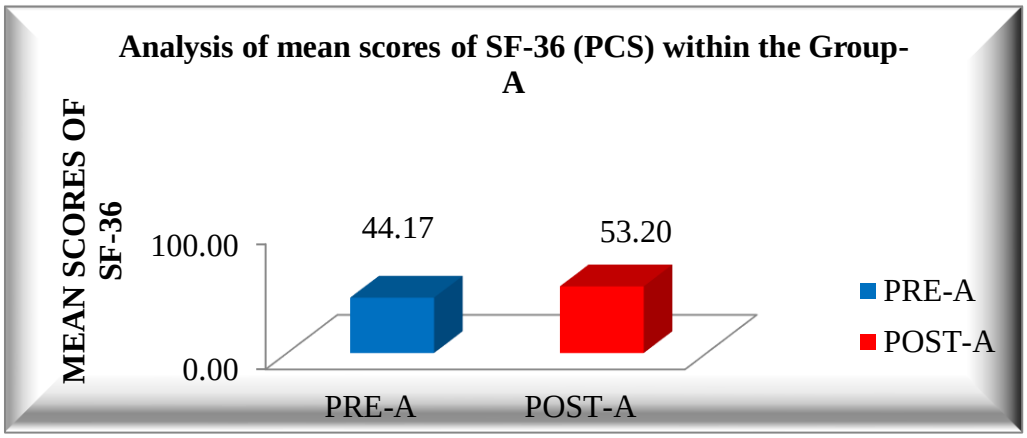

Figure-2: Analysis of Mean scores of SF-36 (PCS) within the Group-B

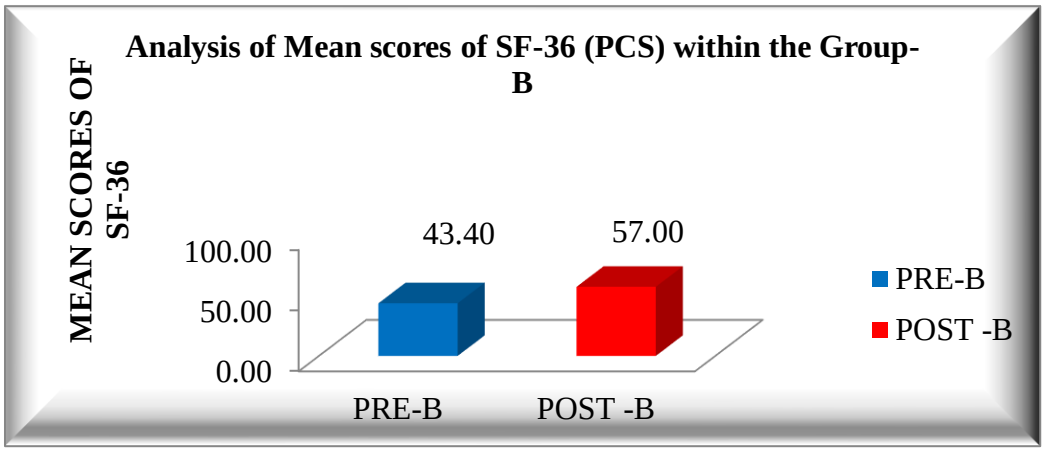

Figure -3: Comparison of Mean scores of SF-36 (PCS) between the Groups-A&B

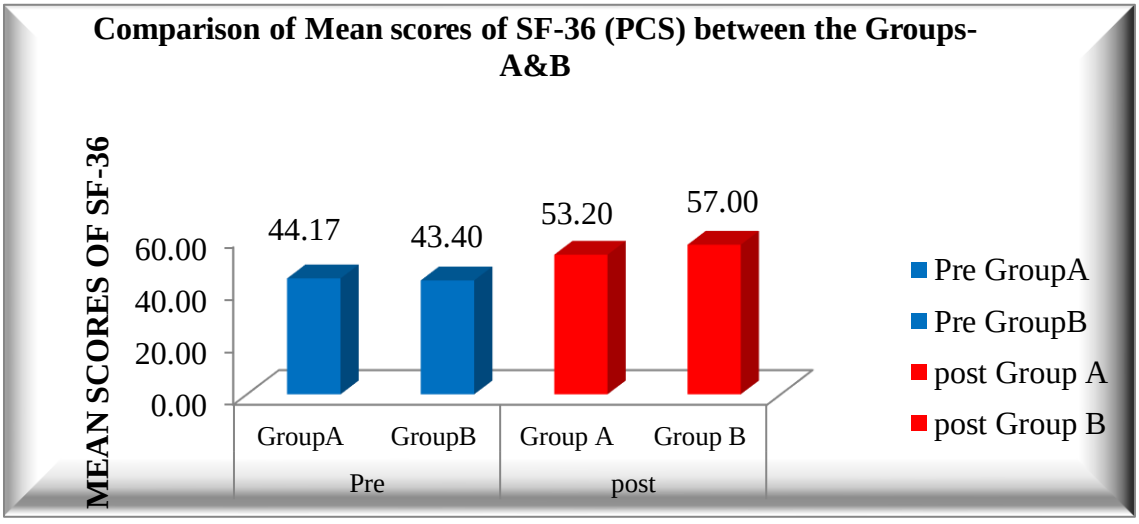

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Figure -4: Analysis of Mean scores of SF-36 (MCS) within the Group-A

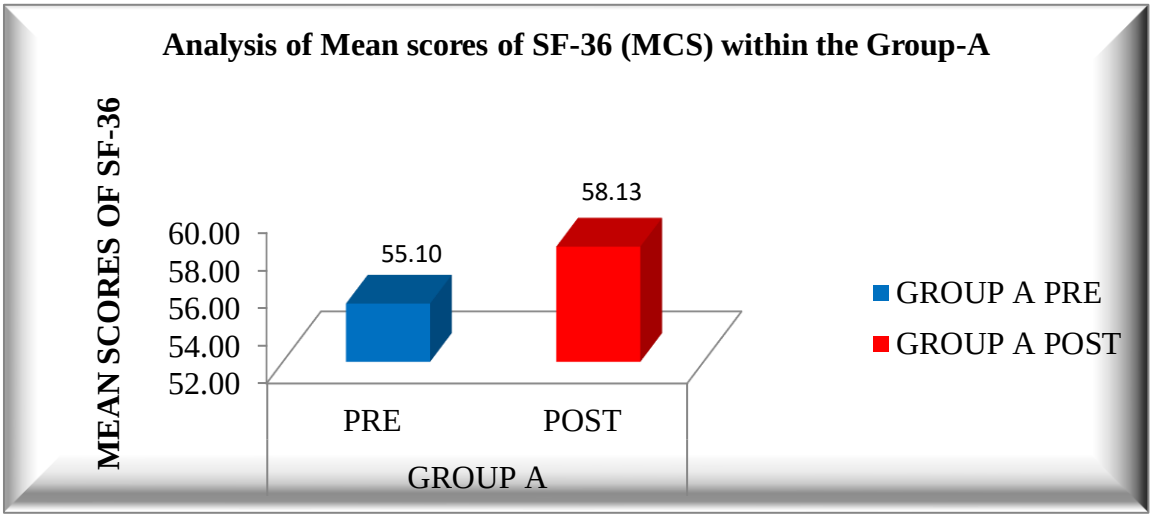

Figure- 5: Analysis of Mean scores of SF-36 (MCS) within the Group-B

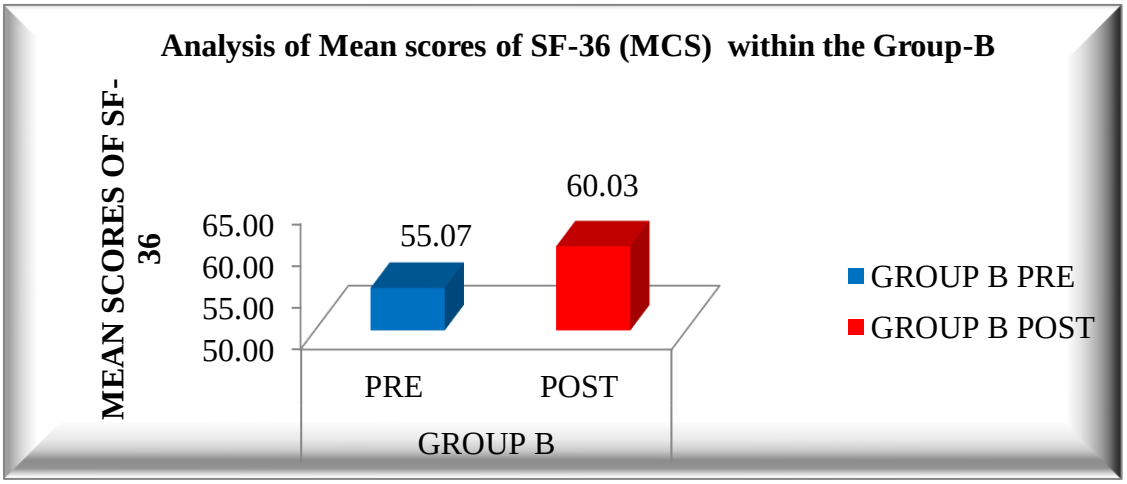

Figure-6: Comparison of Mean scores of SF-36 (MCS) between the Group-A & B

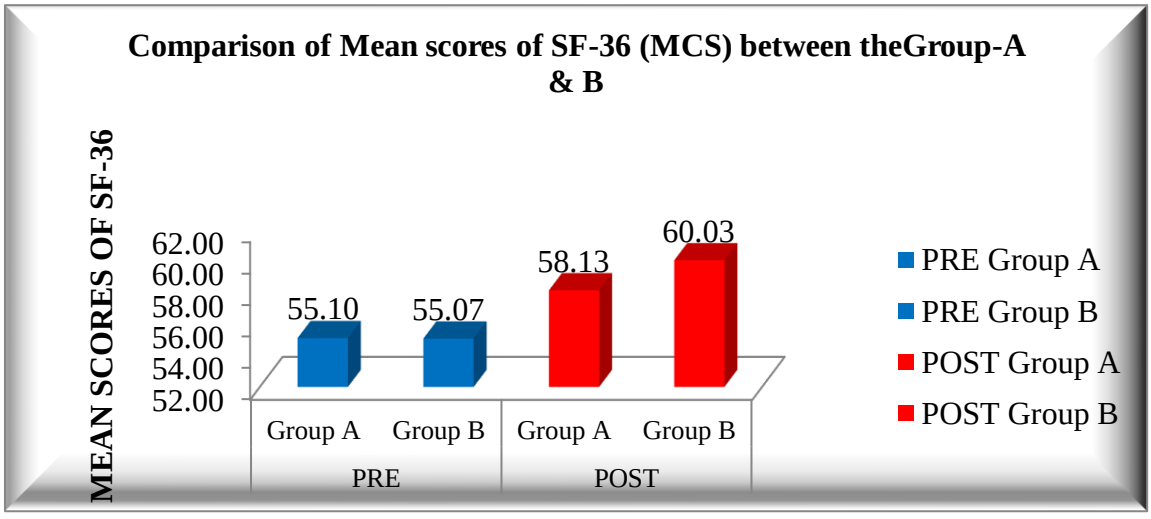

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Figure-7: Analysis of Mean scores of 6MWT within the Group-A

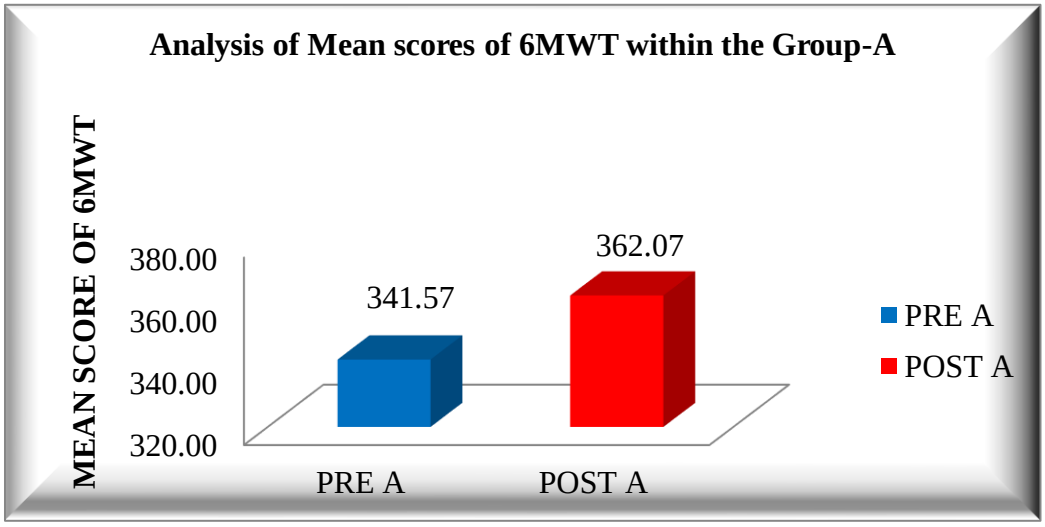


Figure-8: Analyses of mean scores of 6MWT within the Group-B

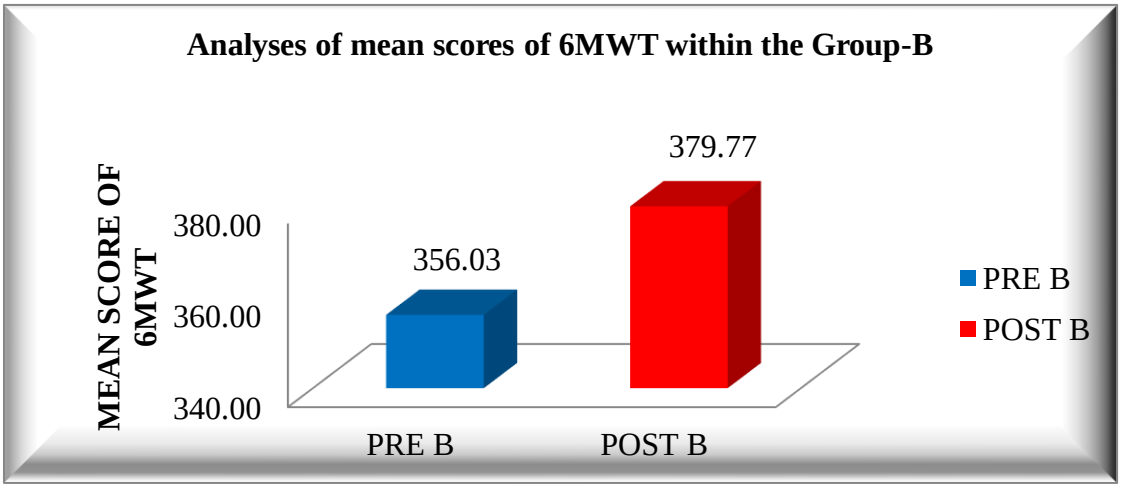
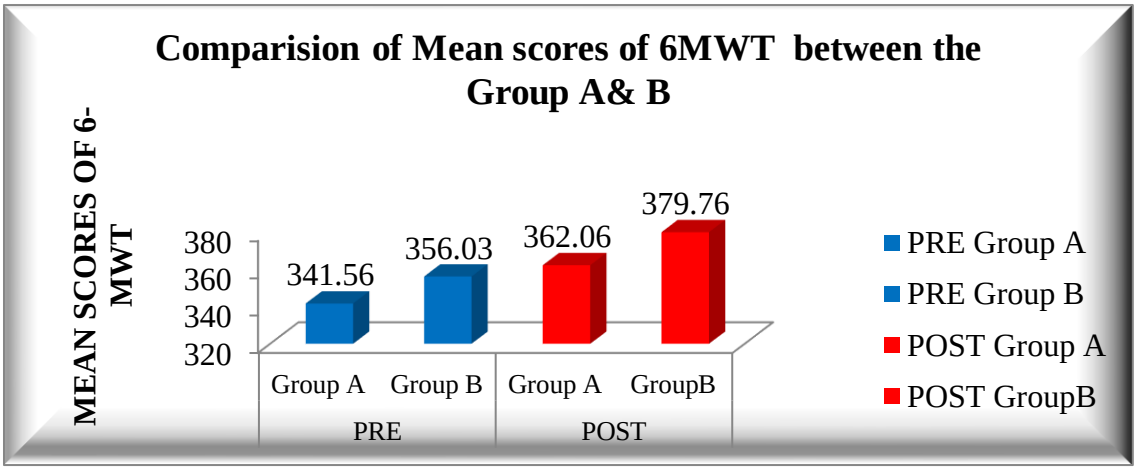


Figure-9: Comparison of Mean scores of 6MWT test between the Groups-A&B



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