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# Comparison of Upper Extremity Strength in Patients with Obstructive Airflow Limitation and Matched Healthy Individuals

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**Abstract:**
**Background:** *Skeletal muscle dysfunction is a common systemic co-morbidity of Chronic Obstructive Airflow Disease (COAD) and is a better predictor of disease mortality than lung function. Patients with severe COAD report a marked increase in the sensation of dyspnea during routine tasks that require arm use, especially activities requiring unsupported arm elevation. COAD patients have altered respiratory mechanics and impaired gas exchange, which decreases physical ability and affects activities of daily living (ADL). As a result of these mechanical changes, many patients with COAD struggle with or even avoid performing essential ADLs that involve upper extremities which mainly does isotonic muscle work. There have been many studies showing reduced skeletal muscle strength and endurance, especially in the lower limbs of COAD patients. However, there has been little research into the upper limb skeletal muscle dysfunction in COAD patients. Hence the objective of the study was to compare upper extremity strength in patients with Obstructive Airflow Limitation (OAL) and matched healthy individuals.*
**Materials and Methods:** *Subjects were screened for inclusion and exclusion criteria and written consent was taken. 40 COAD subjects and 40 healthy matched individuals were included in the study. Upper extremity muscle strength was measured by calculating 1-Repetition Maximum (1-RM) using Brzycki's equation and functional capacity was measured by using 6-Minute Walk Distance (6MWD). Upper extremity muscle strength between the two groups was compared and correlated with 6MWD.Materials used in this study are Measuring tape, Weight cuffs, Height Weight machine, Sphygmomanometer, Stethoscope and Stopwatch.*
**Results:** *1 RM MEAN of Shoulder Flexors, Extensors, Abductors, External rotators and Internal Rotators was significantly lesser than COAD group than healthy normal controls (p< 0.05). There was no statistically significant correlation ((p= 0.244 > 0.05) between 1 RM MEAN and 6MWD.*
**Conclusion:** *There was a statistically significant difference in the upper extremity strength in patients with Obstructive Airflow Limitation when compared to the age, gender and BMI matched healthy individuals (p= 0.000< 0.05).There was no statistically significant correlation between the upper extremity strength and functional capacity in patients with obstructive airflow limitation (p=0.244> 0.05).*
**Key words:** *OAD, COAD, Upper Extremity Strength, 1 RM 6MWT*

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## I. Introduction

Obstructive airflow limitation (OAL) is a major public health problem responsible for substantial morbidity, mortality and health care costs. Most common conditions considered under OAL are COPD which includes Chronic Bronchitis and Emphysema, Bronchiectasis, Cystic Fibrosis. According to the World Health Organization, approximately 210 million people throughout the world have COPD and it is likely to become the third leading cause of death globally by 2030. [2] Patients with OAL have altered respiratory mechanics and impaired gas exchange, which decreases physical ability and affects activities of daily living (ADL). According to Belman, functional loss in COAD patients is also related to gradual loss of muscle conditioning, leading to early anaerobiosis and associated dyspnea at increasingly lower effort levels. [5] Skeletal muscle dysfunction, including muscle weakness and atrophy, is a common systemic co-morbidity of COAD and is a better predictor of disease mortality than lung function. It contributes to exercise limitation leading to a poor quality of life and increased need for medical assistance. [2] Deconditioning has been traditionally suggested as the main reason for the presence of these peripheral muscle abnormalities in patients with COAD. [2] Dyspnea and arm fatigue are common sequelae of unsupported arm exercise in people with COAD and are frequently reported during activities of daily living involving the arms. As unsupported arm activities are required for self-care and independent living. [3] During arm exercise, the accessory muscles of respiration are required for the arm task and may not be able to contribute to breathing. There is a resultant shift in respiratory load to the mechanically disadvantaged diaphragm, which results in thoracoabdominal dyssynchrony and severe dyspnea. In addition, since the muscles that move the arms and stabilize the trunk are attached to the rib cage, this increases chest wall impedance, which limits the ability to increase tidal volume during arm activities. [3] In addition, elevating the arms above the shoulders increases functional residual capacity (FRC) in these patients. This may be explained by the fact that the thoracic muscles are passively stretched expanding the rib cage when the arms are being raised. This higher FRC increases lung hyperinflation resulting in a greater load that must be overcome by the diaphragm, decreasing its capacity for generating force and thus, increasing the sensation of dyspnea. A comparatively simple alternative method, the one repetition maximum (1-RM) determination, has gained acceptance as the Gold Standard for assessing muscle strength. The 1-RM method requires relatively inexpensive non-laboratory equipment. [8] So, specific assessment of peripheral muscle function is essential to identify muscle impairment, prescribe appropriate exercise training and evaluate treatment efficacy. [2]

## II. Materials and Methods

This observational cross sectional study was carried out in Physiotherapy OPD of tertiary health care hospital, Mumbai From August 2015- August 2016. Total 40 subjects were included in the study (both male and female) aged > 40 years.

**Study design**: Observational Cross sectional study
**Study location**: Physiotherapy OPD of tertiary healthcare hospital.
**Study duration**: August 2015-2016
**Sample size**: 40
**Sample size calculation**: Sample size was calculated according to the formula [11]:

$N = 4pq/ L^2$

Where p= Prevalence, q= 1-p
At 92.5% confidence interval L=0.075. Prevalence of COPD in India is 5%,
Hence p=0.05 and q= 1-p= 0.95

$N=4\times0.05\times0.95 \div (0.075)^2 =34$

Rounding off to 40.
Hence N=40.

**Subjects & selection method:** The study population was patients suffering from Obstructive Airflow Limitation
and their age, gender and BMI matched controls. Convenient sampling method was used for the study.
Experimental group- 40 Control group- 40

**Inclusion criteria:**

1. EXPERIMENTAL GROUP :

- Individuals aged 40 years or above.
- Patients with mild, moderate, and severe airway obstruction based on GOLD-stage classification of COPD severity to be included in the study

  Mild: FEV1/FVC < 0.70
  FEV1> 80% of predicted

  Moderate: FEV1/FVC < 0.70
  50% < FEV1< 80% of predicted

  Severe: FEV1/FVC < 0.70
  30% < FEV1< 50% of predicted

- No exacerbation of symptoms in the last 1 month
- Ability to understand the purpose of the study
- Voluntary consent to participate.

2. CONTROL GROUP:

- Age, gender and BMI matched healthy individual.
- Ability to understand the purpose of the study
- Voluntary consent to participate.

**EXCLUSION CRITERIA:**

1. EXPERIMENTAL GROUP:

- Individual suffering from restrictive lung condition

- Presence of any neurological, musculoskeletal and psychological problems.
- Individual using any walking aids.
- Fever or worsening of respiratory symptoms;
- Unstable coronary artery disease;
- Any exacerbation of symptoms in the last 1 month
- Participation in any physical training activities.
- Inability to understand and co-operate.
- Asthma

2. CONTROL GROUP:

- Individual suffering from restrictive lung condition
- Presence of any neurological, musculoskeletal and psychological problems.
- Individual using any walking aids.
- Fever or worsening of respiratory symptoms;
- Unstable coronary artery disease;
- Non smoker healthy individuals.
- Patients who are not willing to participate.
- Participation in any physical training activities.

**Procedure methodology:**

The approval for the study was taken from the local institution Ethics Committee and MUHS research board prior to the commencement of the study.

Subjects coming to the chest OPD were screened, out of which 40 Obstructive Airflow Limitation patients who met the inclusion criteria were included in the experimental group.

Written consent was taken from the participants after explaining the study procedure.

In the control group, relatives of the patients coming in the OPD and healthy normal individuals from the society were screened, then age, gender and BMI matched healthy 40 individuals meeting the inclusion criteria were enrolled after taking their consent to participate in the study.

The basic personal information, anthropometric measures, vital parameters, latest PFT report, level of dyspnea, co-morbidities and information regarding current medication of the participant was taken.

-Procedure for measurement of 1 RM [8] -

- For finding 1 RM of shoulder flexor muscles subject was asked to lie in supine lying position on a plinth of suitable height.
- Tight clothing was avoided to achieve full range of motion. Before starting the test subject was asked to do warm up i.e. active shoulder flexion (10 times).

-Test performance –

- Subject was asked to choose 50% of maximum weight that he/she thinks can lift.
- Subject was asked to hold the weight cuff in their hand.
- Subject was asked to do shoulder flexion with weight cuffs as many times as he/she can.
- Care should be taken that, the repetition should be less than 10 times.

- For finding 1 RM of shoulder extensor subject was asked to lie in prone lying position and same procedure was repeated.

-For finding 1RM of shoulder abductor, subject was asked to lie in side lying position and same procedure was repeated.

- For finding 1 RM of shoulder internal rotators and external rotator musculature, subject was asked to lie in prone lying position with shoulder abducted to 90 degrees and elbow flexed to 90 degrees.
-2 minutes of rest periods was given between each attempts and 3 minutes of rest was given between each specific exercise. [8]

All Obstructive Airflow Limitation subjects and age, gender and BMI matched healthy individuals were assessed for their weight in kilograms (kgs) and height in meters and then body mass index (BMI) was calculated.

**Measurement of Six-Minute Walk Distance (6MWD):** All Obstructive Airflow Limitation subjects were made to do 6 minute walk test to find out the functional capacity of them. 6MWD was carried out using ATS guidelines. [12]

**Statistical analysis:**

1. The SPSS software 16.0 was used for data analysis.
2. In the experimental group dependent variables were 1 RM mean and 6MWD
3. Data was tested for normality using Shapiro Wilk Test.
4. Descriptive data analysis for age, gender, BMI was done in both groups and 1 RM mean and 6MWD was done in Experimental group.
5. Effectiveness of matching of Age, BMI was tested by Pearson's correlation (strong correlation indicating effective matching and paired sampling).
6. Parametric tests were used to test data passing normality and Non-Parametric tests were used to test data not passing normality.
7. Wilcoxon signed rank test (non parametric test for paired sample) was used for the comparison of 1 RM mean of Flexors, 1 RM mean of Extensors, 1 RM mean of Abductors, 1 RM mean of External Rotators and 1 RM mean of Internal Rotators of shoulder between Experimental group and control group (Age, gender and BMI matched healthy individuals).Because of the similarity of the subjects, on the basis of age, gender and BMI, matched designs are treated like same subject design for the purpose of statistical analysis.
8. Spearman correlation test (non parametric test) was used to find the correlation between 1 RM mean of Upper Extremity and 6MWD in Experimental group.
9. At 95% Confidence interval, level of significance was 0.05 (p value $< 0.05$ = significant).

## III. Results

1. Total number of subjects in the study was 80. Number of subjects in each group was 40 each. As the control group was matched with the experimental group in gender, there were 26 males and 14 females in each group.
2. In the control group mean age and BMI were 53.40 ± 7.864 years and 20.44 ± 3.26 kg/m2 and in the experimental group 53.40 ± 7.864 years and 20.56 ± 3.42 kg/m2.
3. On comparison of two groups, a strong correlation was seen for age (r= 1.000) and BMI (r= 0.990) suggesting that both groups were matched with respect to age and BMI.

**Table 1: Gender Distribution**

| | FREQUENCY | PERCENTAGE |
|---|---|---|
| **MALE** | 52 | 65% |
| **FEMALE** | 28 | 35% |
| **TOTAL** | 80 | 100% |

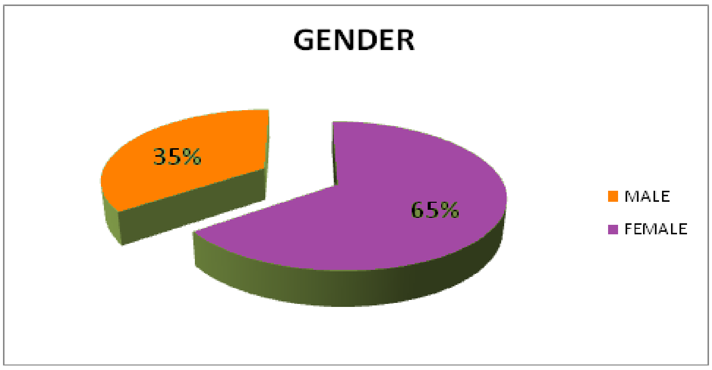



**Table 2: Age and BMI distribution**

| | Control Group | Experimental Group |
|---|---|---|
| | Mean + SD [95% CI] | Mean + SD [95% CI] |
| AGE | 53.40 ± 7.864 (50.88-55.91) | 53.40 ± 7.864 (50.88-55.91) |
| BMI | 20.44 ± 3.26 (19.40-21.49) | 20.56 ± 3.42 (19.46-21.65) |

**Table no.3: Test for matching of data: ( Pearson correlation)**

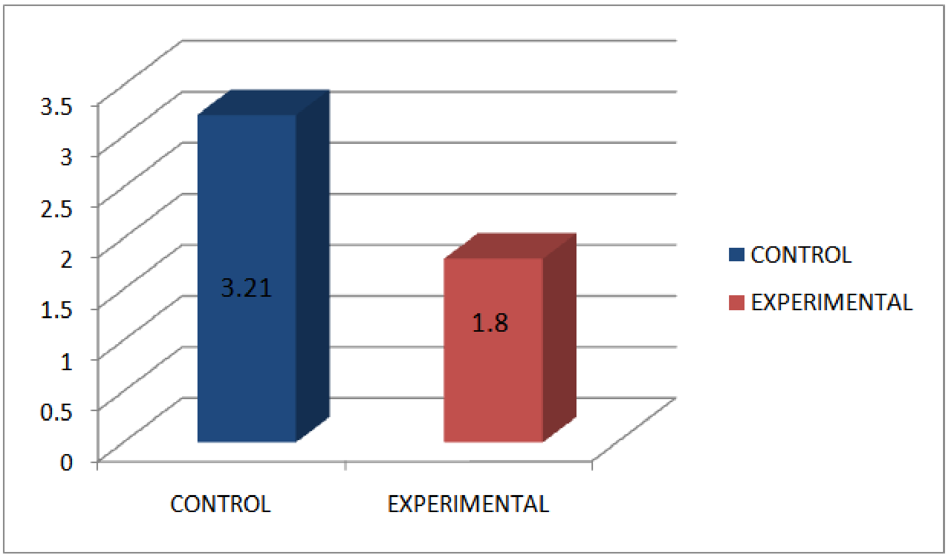
****. Correlation is significant at the 0.01 level (two-tailed).**

| | | AGE | AGE | BMI | BMI |
|---|---|---|---|---|---|
| **EXPERIMENTAL GROUP** | PEARSON CORRELATION | 1 | 1.000** | 1 | 0.990** |
| | Sig. (two-tailed) | | 0.000 | | 0.000 |
| | N | 40 | 40 | 40 | 40 |
| **CONTROL GROUP** | PEARSON CORRELATION | 1.000** | 1 | 0.990** | 1 |
| | Sig. (two-tailed) | 0.000 | | 0.000 | |
| | N | 40 | 40 | 40 | 40 |

Table shows the test for pairing between the two groups. On comparing the two groups, a strong correlation was seen for age (r=1.000) and BMI (r=0.990) suggesting that the Control group and Experimental group were matched with respect to age and BMI.

**Table no 4:**

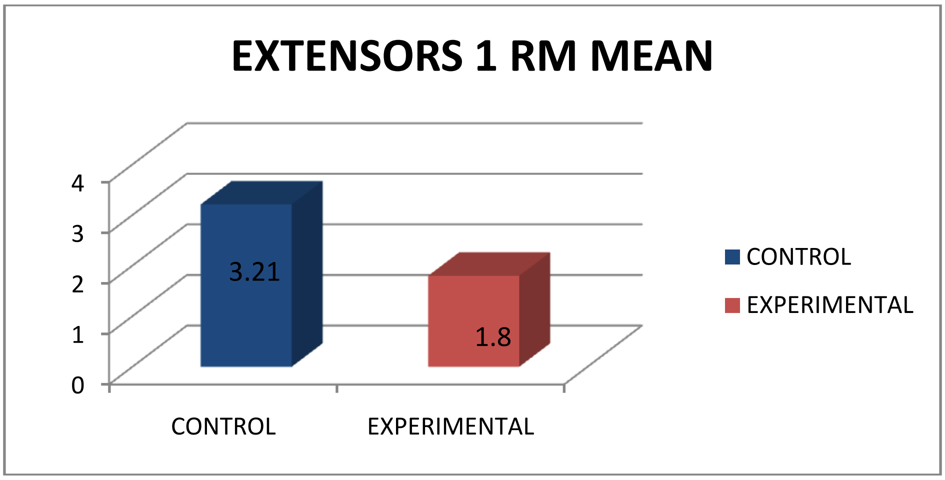
| Group | Mean ± SD | 95% CI | Median |
|---|---|---|---|
| **Control** | 3.53± 0.80 | 3.28-3.79 | 3.21 |
| **Experimental** | 1.97± 0.83 | 1.70-2.23 | 1.80 |




The above table and graph shows Descriptive analysis of 1 RM MEAN of Flexors in Control group and Experimental group. Mean 1 RM of flexors was 3.53± 0.80 (95% CI 3.28-3.79) in the control group and 1.97± 0.83 (95% CI 1.70-2.23) in the Experimental group. Median was in 1.80 experimental group and 3.21 in Control group.

**Table no 5:**

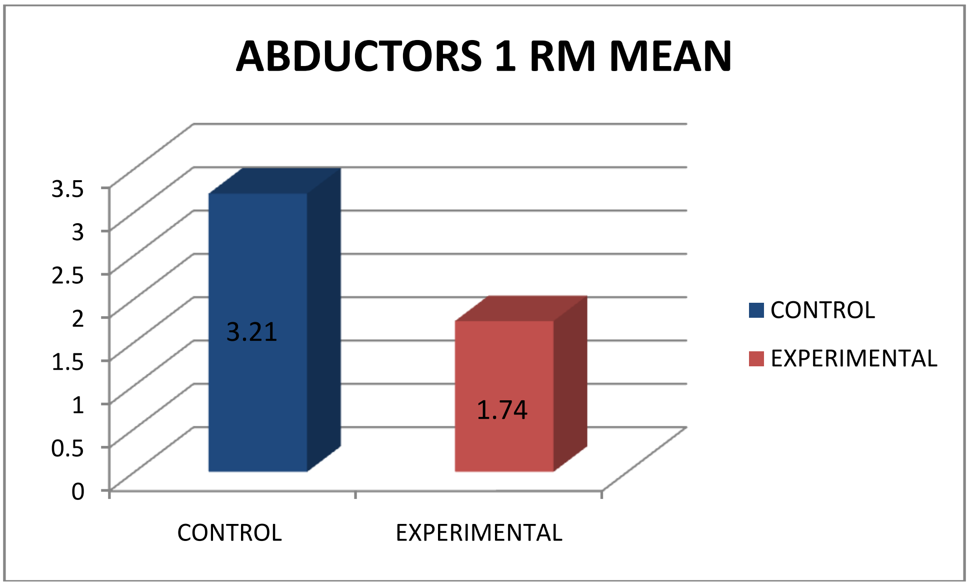
| Group | Mean ± SD | 95% CI | Median |
|---|---|---|---|
| **Control** | 3.52 ± 0.81 | 3.26-3.78 | 3.21 |
| **Experimental** | 1.91 ± 0.69 | 1.69-2.13 | 1.80 |




The above table and graph shows Descriptive analysis of 1 RM MEAN of Extensors in Control group and Experimental group. Mean 1 RM of extensors was 3.52± 0.81 (95% CI 3.26-3.78) in the control group and 1.91 ± 0.69 (95% CI 1.69-2.13) in the Experimental group. Median was in 1.80 experimental group and 3.21 in Control group.

**Table no 6:**

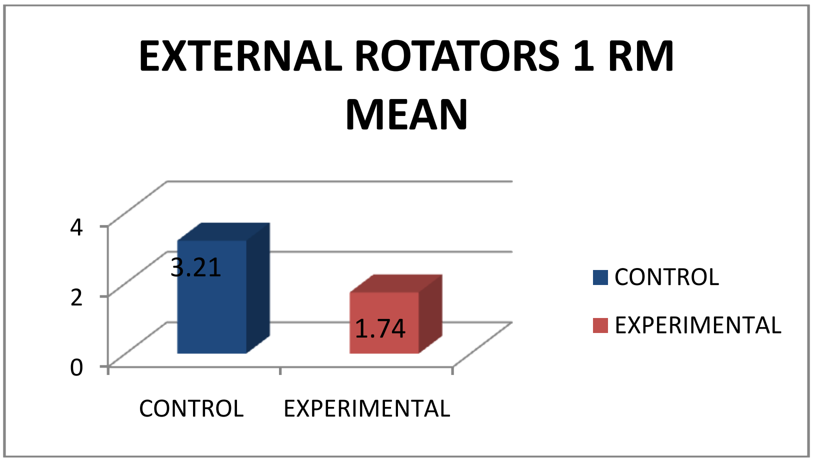
| Group | Mean ± SD | 95% CI | Median |
|---|---|---|---|
| **Control** | 3.51 ± 0.77 | 3.27-3.76 | 3.21 |
| **Experimental** | 1.86 ± 0.79 | 1.61-2.12 | 1.74 |




The above table and graph shows Descriptive analysis of 1 RM MEAN of Abductors in Control group and Experimental group. Mean 1 RM of Abductors was 3.51± 0.77 (95% CI 3.27-3.76) in the Control group and 1.86 ± 0.79 (95% CI 1.61-2.12) in the Experimental group. Median was in 1.74 Experimental group and 3.21 in Control group.

**Table no 7:**

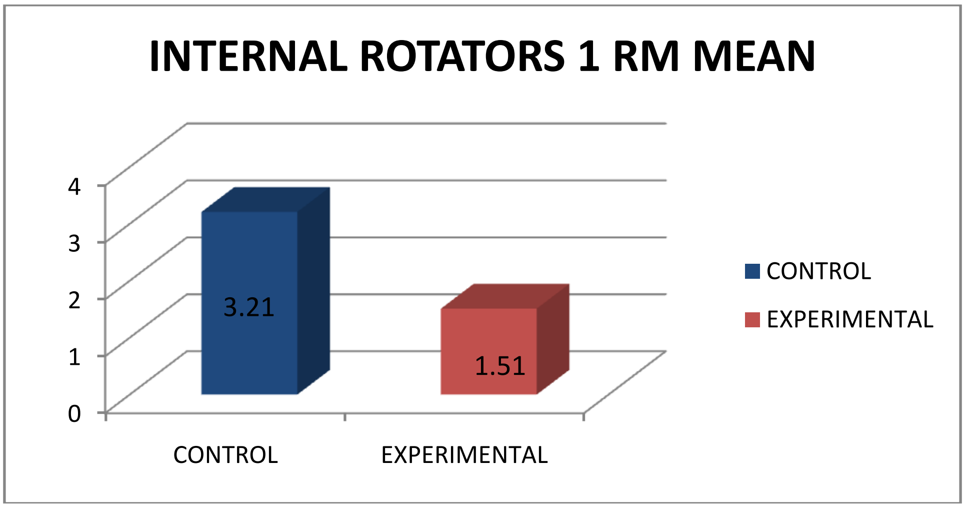
| Group | Mean ± SD | 95% CI | Median |
|---|---|---|---|
| **Control** | 3.45 ± 0.74 | 3.21-3.69 | 3.21 |
| **Experimental** | 1.75 ± 0.62 | 1.55-1.95 | 1.74 |




The above table shows Descriptive analysis of 1 RM MEAN of External Rotators in Control group and Experimental group. Mean 1 RM of External Rotators was 3.45± 0.74 (95% CI3.21-3.69 ) in the Control group and 1.75 ± 0.62 (95% CI 1.55-1.95 ) in the Experimental group. Median was in 1.74 Experimental group and 3.21 in Control group.

**Table no 8:**

| Group | Mean ± SD | 95% CI | Median |
|---|---|---|---|
| **Control** | 3.44 ± 0.77 | 3.19-3.68 | 3.21 |
| **Experimental** | 1.71 ± 0.62 | 1.51-1.91 | 1.51 |




The above table shows Descriptive analysis of 1 RM MEAN of Internal Rotators in Control group and Experimental group. Mean 1 RM of Internal Rotators was 3.44± 0.77 (95% CI 3.19 -3.68) in the Control group and 1.71 ± 0.62 (95% CI 1.51-1.91) in the Experimental group. Median was 1.51 in Experimental group and 3.21 in Control group.

**Table 9: Comparison of 1 RM MEAN OF FLEXORS in both groups:**

**Ranks**

| | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| FLEXORS_MEAN_EXPERIMENTAL - FLEXORS_MEAN_CONTROL | Negative Ranks | 39[a] | 20.00 | 780.00 |
| | Positive Ranks | 0[b] | .00 | .00 |
| | Ties | 1[c] | | |
| | Total | 40 | | |

a. FLEXORS_MEAN_EXPERIMENTAL < FLEXORS_MEAN_CONTROL

b. FLEXORS_MEAN_EXPERIMENTAL > FLEXORS_MEAN_CONTROL

**Ranks**

| | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| FLEXORS_MEAN_EXPERIMENTAL - FLEXORS_MEAN_CONTROL | Negative Ranks | 39[a] | 20.00 | 780.00 |
| | Positive Ranks | 0[b] | .00 | .00 |
| | Ties | 1[c] | | |
| | Total | 40 | | |

a. FLEXORS_MEAN_EXPERIMENTAL < FLEXORS_MEAN_CONTROL

b. FLEXORS_MEAN_EXPERIMENTAL > FLEXORS_MEAN_CONTROL

c. FLEXORS_MEAN_EXPERIMENTAL = FLEXORS_MEAN_CONTROL

**Test Statistics**[b]

| | FLEXORS_MEAN_EXPERIMENTAL - FLEXORS_MEAN_CONTROL |
|---|---|
| Z | -5.443[a] |
| Asymp. Sig. (2-tailed) | .000 |

a. Based on positive ranks.

The above table shows the comparison of 1 RM Mean of Flexors in both Control and Experimental group. Based on positive ranks, 1 RM Mean of Flexors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

**Table 10: Comparison of 1 RM MEAN OF EXTENSORS in both groups:**

**Ranks**

| | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| EXTENSORS_MEAN_EXPERIMENTAL - EXTENSORS_MEAN_CONTROL | Negative Ranks | 39[a] | 20.00 | 780.00 |
| | Positive Ranks | 0[b] | .00 | .00 |
| | Ties | 1[c] | | |
| | Total | 40 | | |

**Test Statistics**[b]

| | EXTENSORS_MEAN_EXPERIMENTAL - EXTENSORS_MEAN_CONTROL |
|---|---|
| Z | -5.443[a] |
| Asymp. Sig. (2-tailed) | .000 |

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

The above table shows the comparison of 1 RM Mean of Extensors in both Control and Experimental group. Based on Positive ranks, 1 RM Mean of Extensors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

**Table 11: Comparison of 1 RM MEAN OF ABDUCTORS in both groups:**

**Ranks**

| | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| ABDUCTORS_MEAN_EXPERIMENTAL - ABDUCTORS_MEAN_CONTROL | Negative Ranks | 39[a] | 20.00 | 780.00 |
| | Positive Ranks | 0[b] | .00 | .00 |
| | Ties | 1[c] | | |
| | Total | 40 | | |

a. ABDUCTORS_MEAN_EXPERIMENTAL < ABDUCTORS_MEAN_CONTROL

b. ABDUCTORS_MEAN_EXPERIMENTAL > ABDUCTORS_MEAN_CONTROL

c. ABDUCTORS_MEAN_EXPERIMENTAL = ABDUCTORS_MEAN_CONTROL

**Test Statisticsb**

| | ABDUCTORS_MEAN_EXPERIMENTAL - ABDUCTORS_MEAN_CONTROL |
|---|---|
| Z | -5.445[a] |
| Asymp. Sig. (2-tailed) | .000 |

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

The above table shows the comparison of 1 RM Mean of Abductors in both Control and Experimental group. Based on Positive ranks, 1 RM Mean of Abductors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

**Table 12: Comparison of 1 RM MEAN OF EXTERNAL ROTATORS in both groups:**

**Ranks**

| | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| EXTERNAL_ROTATORS_MEAN_EXPERIMENTAL - EXTERNAL_ROTATORS_MEAN_CONTROL | Negative Ranks | 40[a] | 20.50 | 820.00 |
| | Positive Ranks | 0[b] | .00 | .00 |
| | Ties | 0[c] | | |
| | Total | 40 | | |

a. EXTERNAL_ROTATORS_MEAN_EXPERIMENTAL < EXTERNAL_ROTATORS_MEAN_CONTROL

b. EXTERNAL_ROTATORS_MEAN_EXPERIMENTAL > EXTERNAL_ROTATORS_MEAN_CONTROL

c. EXTERNAL_ROTATORS_MEAN_EXPERIMENTAL = EXTERNAL_ROTATORS_MEAN_CONTROL

**Test Statistics[b]**

| | EXTERNAL_ROTATORS_MEAN_EXPERIMENTAL - EXTERNAL_ROTATORS_MEAN_CONTROL |
|---|---|
| Z | -5.512[a] |
| Asymp. Sig. (2-tailed) | .000 |

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

The above table shows the comparison of 1 RM Mean of External Rotators in both Control and Experimental group. Based on Positive ranks, 1 RM Mean of External Rotators was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

**Table 13 : Comparison of 1 RM MEAN OF INTERNAL ROTATORS in both groups:**

**Ranks**

| | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| INTERNAL_ROTATORS_MEAN_EXPERIMENTAL - INTERNAL_ROTATORS_MEAN_CONTROL | Negative Ranks | 39[a] | 20.00 | 780.00 |
| | Positive Ranks | 0[b] | .00 | .00 |
| | Ties | 1[c] | | |
| | Total | 40 | | |

a. INTERNAL_ROTATORS_MEAN_EXPERIMENTAL < INTERNAL_ROTATORS_MEAN_CONTROL

b. INTERNAL_ROTATORS_MEAN_EXPERIMENTAL > INTERNAL_ROTATORS_MEAN_CONTROL

c. INTERNAL_ROTATORS_MEAN_EXPERIMENTAL = INTERNAL_ROTATORS_MEAN_CONTROL

**Test Statistics[b]**

| | INTERNAL_ROTATORS_MEAN_EXPERIMENTAL - INTERNAL_ROTATORS_MEAN_CONTROL |
|---|---|
| Z | -5.444[a] |
| Asymp. Sig. (2-tailed) | .000 |

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

The above table shows the comparison of 1 RM Mean of Internal Rotators in both Control and Experimental group. Based on Positive ranks, 1 RM Mean of Internal Rotators was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

**TABLE 14: DESCRIPTIVE ANALYISIS OF 1 RM MEAN AND 6MWD OF EXPERIMENTAL GROUP:**

| EXPERIMENTAL GROUP | Mean ± SD | 95 % CI |
|---|---|---|
| 1 RM MEAN | 1.84 ± 0.69 | 1.62-2.06 |
| 6MWD | 342.89 ± 69.844 | 3.20- 365.23 |

The above table shows Descriptive analysis of 1 RM MEAN and 6MWD in Experimental group. Mean of 1 RM MEAN of Upper Extremity was 1.84 ± 0.69 (95% CI 1.62-2.06) and 6MWD was 3.4289E2 ± 6.9844E1.

**TABLE 15: CORRELATION OF 1 RM MEAN WITH 6MWD (SPEARMAN'S CORRELATION): Correlations**

| | | | ONE_RM_MEAN | SIX_MWD |
|---|---|---|---|---|
| Spearman's rho | ONE_RM_MEAN | Correlation Coefficient | 1.000 | -.189 |
| | | Sig. (2-tailed) | . | .244 |
| | | N | 40 | 40 |
| | SIX_MWD | Correlation Coefficient | -.189 | 1.000 |
| | | Sig. (2-tailed) | .244 | . |
| | | N | 40 | 40 |

The above table shows the correlation between the 1 RM MEAN and 6 MWD. The spearman correlation coefficient was -.189 suggesting a positive linear correlation between the 1 RM MEAN and 6 MWD which was statistically not significant (p = 0.244 which is > 0.05).

## IV. Discussion

Obstructive Airflow Limitation is a chronic debilitating disease with disabling symptoms. [13] It has significant systemic effects that substantially impact quality of life and survival. [14] The progression of disease and deterioration in pulmonary function increases alveolar hypoxia and ultimately increases the risk of hypoxemia. Physical inactivity is considered an important marker of advanced COAD. Reduced skeletal muscle oxidative capacity can have a negative effect on exercise capacity and physical activity in COAD patients. [15]

The aim and objectives of the study were to compare upper extremity strength in subjects with Obstructive airflow limitation and matched healthy individuals:

Total 97 subjects were screened randomly. Out of which 47 were selected for the experimental group and 50 subjects for the control group. For experimental group total 47 subjects with Obstructive Airflow Limitation were screened. Out of 47 subjects, 40 subjects meeting the inclusion criteria were included in the study after taking their consent and 7 subjects were excluded (5 subjects= did not match the inclusion criteria, 2=unwilling to participate in the study). For the control group, 50 age, gender, BMI matched healthy individuals were screened. Out of which 10 subjects meeting the inclusion criteria were included in the study after taking their consent and 10 were excluded (7 subjects= did not match the inclusion criteria, 3= participated in another physical activity).So finally, total 80 subjects were enrolled in this study. Upper extremity muscle strength was measured by 1 RM using Bryzcki's equation. Data for 1 RM Mean of shoulder Flexors, Extensors, Abductors, External Rotators and Internal Rotators and 6MWD was collected and statistically analyzed using SPSS 16.0. Nele ceilen, Karen Maes and Ghislaine Gayan- Ramirez studied Musculoskeletal Disorders in OAL which stated that skeletal muscle weakness is of major concern, since it leads to poor functional capacity, impaired health status, increased healthcare utilization, and even mortality, independently of lung function. Therefore, the presence of the combination of these co morbidities will have a negative impact on daily life. [16]

The upper extremities (UEs) play an important role in performing many activities of daily living (ADL), both in the domain of basic self-care and in everyday jobs. Patients with chronic airway obstruction (CAO) frequently experience marked dyspnea and fatigue when performing these tasks, which commonly require unsupported arm work and, therefore, pose a unique challenge to these individuals, whose upper-limb muscles are frequently recruited as accessory inspiratory muscles. [17] During unsupported arm exercise, the participation of these muscles in ventilation decreases, and there is a shift of respiratory work to the diaphragm, which is commonly weakened and has a reduced functional capacity in these patients. [17] Deconditioning and atrophy is a major contributor to the skeletal muscle dysfunction seen in patients with COAD. These patients generally assume a sedentary lifestyle to avoid the dyspnoea that physical activity brings. [3,19] Exercise performance depends on aerobic metabolism and oxidative capacity. Hypoxemia leads to the conversion of aerobic metabolism to anaerobic metabolism in low levels of physical activity in COAD. Reduced skeletal muscle oxidative capacity can have a negative effect on exercise capacity and physical activity in COAD patients. (Shown in table 9-13) [15]

Table 9 shows the comparison of 1 RM Mean of Flexors in both Control and Experimental group by using Wilcoxon Signed Rank Test. Based on positive ranks, 1 RM Mean of Flexors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

Table 10 shows the comparison of 1 RM Mean of Extensors in both Control and Experimental group by using Wilcoxon Signed Rank test. Based on Positive ranks, 1 RM Mean of Extensors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

Table 11 shows the comparison of 1 RM Mean of Abductors in both Control and Experimental group by using Wilcoxon Signed Rank Test. Based on Positive ranks, 1 RM Mean of Extensors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

Table 12 shows the comparison of 1 RM Mean of External Rotators in both Control and Experimental group by using Wilcoxon Signed Rank Test. Based on Positive ranks, 1 RM Mean of Extensors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

Table 13 shows the comparison of 1 RM Mean of Internal Rotators in both Control and Experimental group by using Wilcoxon Signed Rank Test. Based on Positive ranks, 1 RM Mean of Extensors was weaker in Experimental group than Control group which was statistically significant (p value < 0.05).

Therefore from table 9,10,11,12 and 13 it was clinically evident that there was reduction in upper extremity strength in Obstructive Airway Disease subjects when compared it with age, gender and BMI matched healthy individuals which was statistically significant.

M. Jeffery Mador and Erkan Bozkanat performed a study on skeletal muscle dysfunction in chronic obstructive pulmonary disease. They stated that there is a reduced proportion of type I fibers and an increase in type II fibers. Type I fibers are slow-twitch fibers, develop a relatively small tension, have increased oxidative capacity, and are resistant to fatigue. Type IIb fibers are fast-twitch fibers, develop high tensions, depend primarily on anaerobic glycolytic metabolism, and are highly susceptible to fatigue. [13]

Beate Rassler performed a study on "Impaired function of upper limb muscle in patients with Chronic

Obstructive Pulmonary Disease" which states that a major problem among secondary impairments in COPD is skeletal muscle dysfunction, characterized by decreased muscle strength and endurance. He found out various factors contributing to this were inactivity and deconditioning, impaired metabolic situation, structural alteration of skeletal muscles, inflammation and oxidative stress. [20]

Exercise training is now considered an essential component of pulmonary rehabilitation. Although it does not change pulmonary function, exercise training improves exercise capacity and reduces dyspnea. Whether the goal of training should be strength, endurance, or both is still under investigation. On the other hand, exercise programs must be maintained because benefits generally disappeared rapidly if exercise is discontinued. [6]

Pulmonary rehabilitation programs improve exercise capacity by reducing both dynamic hyperinflation mid dyspnea in patients with COAD. An arm-training program (ATP) leads to reduction in ventilatory requirements for simple arm elevation and increases the exercise level. [21] Strength training has also been associated with increased skeletal muscle oxidative capacity and may represent a useful addition to training in patients with COAD. [6]

Physical exercise is an important component of respiratory rehabilitation because it reverses skeletal muscle dysfunction, a clinically important manifestation of COAD associated with reduced health-related quality of life (HRQL) and survival. [14]

**Functional Capacity:**

Table 14 shows Descriptive analysis of 1 RM MEAN and 6MWD in Experimental group. Mean of 1 RM MEAN of Upper Extremity was 1.84 ± 0.69 (95% CI 1.62-2.06) and 6MWD was 342.89 ± 69.844.

Table 15 shows correlation of (spearman's correlation) 1 RM MEAN with 6MWD. The spearman correlation coefficient was -.189 suggesting a positive linear correlation between the 1 RM MEAN and 6 MWD which was statistically not significant (p = 0.244 which is > 0.05).

Typically, longer exercise programs produce greater physiological training effects, with a recommended minimum of 8 weeks to achieve a substantial effect. [23] Probably this could be the reason for correlation of 1 RM MEAN and 6MWD not coming statistically significant.

Francisco Ortega, Javier Toral, Pilar Cejudo et.al performed a study on Comparison of effects of Strength and Endurance Training in Patients with Chronic Obstructive Pulmonary Disease, which stated that Exercise training is now considered an essential component of pulmonary rehabilitation. Although it does not change pulmonary function, exercise training improves exercise capacity and reduces dyspnea. Whether the goal of training should be strength, endurance, or both is still under investigation. On the other hand, exercise programs must be maintained because benefits generally disappeared rapidly if exercise is discontinued. Strength training has also been associated with increased skeletal muscle oxidative capacity and may represent a useful addition to training. [5]

Nyberg A., Tornberg A., Wadell K. performed a Randomized Control Trial on Correlation between Limb Muscle Endurance, Strength, and Functional Capacity in People with Chronic Obstructive Pulmonary Disease. Stationary dynamometer was used to measure isokinetic muscle strength and endurance, 6MWD, 6 Minute Peg Board and Ring Test and unsupported Upper Limb exercises were used to measure functional capacity. The study concluded that, functional capacity seems to be more closely related to limb muscle endurance than to limb muscle strength in COPD. [25]

To summarize, Obstructive Airflow Limitation patients have reduced Upper Extremity Strength when compared it with age, gender and BMI matched healthy individuals. This reduced upper extremity strength was due to disuse( deconditioning effects), change in skeletal muscle fibre type, decreased oxidative capacity, acute hypercapnic respiratory failure, nutritional depletion and increased plasma concentration of lipid peroxidation products. [13] Also there is no significant statistical correlation between the upper extremity strength and 6MWD.

## V. Conclusion

There is statistically significant difference in the upper extremity strength in patients with Obstructive Airflow Limitation when compared to the age, gender and BMI matched healthy individuals (p= 0.000< 0.05).

There is positive correlation between the upper extremity strength and functional capacity in patients with obstructive airflow limitation (correlation coefficient= -.189) which was statistically not significant (p=0.244> 0.05).

Fewer limitations of the study were sample size was small, upper extremity strength was not compared with the severity of the disease and sample size was collected from one institution, hence these results cannot be generalised for entire population.

However, in spite of these limitations, the study presents new perspective which may be an initial step toward future treatment. This may represent yet another valuable tool in pulmonary rehabilitation.

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