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To Compare Effect of Upper Extremity and Lower Extremity Exercise Training on Pulmonary Function in Normal Healthy Young Women

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Abstract: ***Background:*** *healthy young female is at risk of developing pulmonary complication due to increase pollution in environment. Hence monitoring physical fitness is an important factor to live normal healthy life. PFT is one of the most reliable and valid tests to measure respiratory fitness.* ***Objective:*** *To compare the effect of upper extremity and lower extremity exercise training on pulmonary function in normal healthy young female.* ***Methods:*** *Sixty subjects were randomly selected and assigned to two groups through block randomization. They were assessed on the basis of pulmonary function test. Subjects in group-A has received upper extremity exercise training and group-B has received lower extremity exercise training. They underwent exercise training five days a week for six weeks. Outcome measures used in the study were FVC, FEV1, and MVV that is pulmonary function test was taken pre and post training.* ***Results:*** *Upper extremity and lower extremity exercise training resulted in significant improvement in pulmonary function. But lower extremity exercise training was comparatively better than the upper extremity exercise training to improve pulmonary function in short duration.* ***Conclusion:*** *Efficacy of lower extremity exercise is higher over upper extremity exercise training on pulmonary function in normal healthy young female.*

Keywords: PFT, Respiratory system physiology, upper and lower extremity exercise, young healthy female

1. Introduction

Regular exercise is a critical part of staying healthy. People who are active live longer and feel better. Exercise can help you to maintain health. It can delay or prevent cardio-vascular and pulmonary disease.[1]

Lack of physical activity and obesity in children and in adolescent are a major cause of cardio-vascular and pulmonary disease. Also because of our life style and pollution increase the risk of pulmonary diseases. Hence monitoring physical fitness is an important factor to live a normal life. [2]

Time have changed since bed rest was considered the greatest advance of which practical medicine can boast in the last quarter century, (plyfair, 1881) much encouragement is required to assist a patient toward a life style of regular exercise.[1]

Those who think they have not time for bodily exercise will sooner or later have to find time for illness. (Edward Stanley). Young adult needs at least 30 minutes of moderate physical activity at least five days per week.[3]

Physical activity must be considered as a life time pursuit. The benefits of a sound exercise program are rapidly lost once, that program is discontinued. Physical fitness comprises two related concepts general fitness (a state of health and wellbeing) and specific fitness (a task – oriented definitions based on the ability to perform specific aspect of sports or occupation). Physical fitness is generally achieved through correct exercise, nutrition and enough rest.[4]

In previous years, fitness was commonly defined as the capacity to carry out the day's activity without undue fatigue. However, as automation increase leisure time, changes in life style following the industrial revolution rendered this definition insufficient. These days, physical fitness is considered a measure of the body's ability to function efficiently and effectively in work and leisure activities, to be healthy, to resist hypo kinetic disease and to meet emergency situations.[6]

Upper and lower extremity exercise training is beneficial to improve respiratory function and to improve fitness. But, which exercise training is more beneficial to improve respiratory function in short duration is not well documented.

The commonest respiratory disorder in India is chronic airway obstruction caused by chronic bronchitis and emphysema. COPD (chronic obstructive pulmonary disease) is a disorder characterized by the presence of airflow obstruction that is generally slowly progressive, may be accompanied by airway hyper reactivity, and may be partially reversible which limit physical activity.[9, 10]

It is one of the most common disabling conditions in young and elderly people. It rank third most common cause if certified illness in U.K. and fifth greatest cause of disability worldwide (WHO 1996) and it is the major cause of death increasing in prevalence. This has inspired me to take this topic for my study to reduce risk of respiratory disorder and improve fitness at young age.[10]

Years ago, patients with chronic pulmonary disease were given a standard prescription for rest and avoidance of exercise. Well in 1960, the stress imposed by exercise was considered deleterious to people with pulmonary disorders. They were treated as invalids, sometimes being referred to as "respiratory cripples".

A 1964 study by pierce et al. provided the impetus to change direction in the treatment of pulmonary dysfunction and documented exercise training effect in their subject with pulmonary disease.[9]

These training effect included decrease in exercising heart rate, respiratory rate, minute ventilation, oxygen consumption and carbon dioxide production at a given work load and increase exercise tolerance has been documented.

Many patients with pulmonary disease report dyspnea and fatigue early when they are performing upper extremity functional activity compare to lower extremity functional activity.[11, 12]

Upper and lower extremity exercise training is beneficial to improve respiratory function and to improve fitness. But, which exercise training is more beneficial to improve respiratory function in short duration is not well documented.

Pulmonary function testing provides valuable information on the mechanical and physiological characteristic of the lung in health and disease. Proper lung function is determined by means of pulmonary function test. So, this study is going to determine the PFT changes of normal healthy individual with upper and lower extremity exercises training.[18]

The effectiveness of pulmonary rehabilitation program has been well documented, with consistent and clinically significant improvement in exercise capacity, and health related quality of life. However, such programs primarily focus on lower extremity exercise training.[25]

But, the recent guideline from American thoracic society recommends the introduction of upper extremity exercise training in pulmonary rehabilitation. I think that this recommendation relies on to clarify the effect of upper extremity exercise training, implemented over and above lower extremity exercise training on normal healthy people.[25]

Also lack of time for exercise in our busy life-style makes it important to study which exercise training is more beneficial to improve respiratory function.[44]

So, the purpose of the study to prescribe beneficial and proper exercise to normal healthy individual to improve respiratory fitness and to prescribe proper exercise to chronic obstructive pulmonary disease patient.

PFT:
PFT is valuable tools for evaluating the respiratory system .it can be used to assess health status before enrollment in strenuous physical activity

A spirometer is an instrument that directly measure the volume of air displaced or measure airflow by a flow sensing device. Such as micro-processor driven pneumotachometer and then mathematically derive volume. Spiro gram provides important graphical and numerical data regarding the mechanical properties of the lungs, including FVC, $FEV_{1,}$ MVV, FEV1/FVC.

Aims and Objectives

Aim of the study:
To compare the effect of upper and lower extremity exercise training on pulmonary function in normal healthy young female.
The purpose of the study is to advise proper exercise prescription or training to normal healthy young female to improve respiratory fitness.

Objectives of the study
1) To determine the effect of upper extremity exercise training on PFT (pulmonary function test).
2) To determine the effect of lower extremity exercise training on PFT (pulmonary function test).
3) To compare the effectiveness of upper extremity exercise training versus lower extremity exercise training on PFT (pulmonary function test).

Hypotheses:

Null hypothesis:
1) Group – A does not have any significant changes on pulmonary function (FEV1, FVC and FEV1/FVC, MVV) on account of upper extremity exercise training for 6 weeks.
2) Group- B does not have any significant changes on pulmonary function (FEV1, FVC and FEV1/FVC, MVV) on account of lower limb extremity exercise training for 6 weeks.
3) Group – A and B do not have any significant changes on pulmonary function (FEV1, FVC, and FEV1/FVC, MVV) of 6 weeks training.

Alternate hypothesis:
1) Group-A has significant changes on pulmonary function (FEV1, FVC, and FEV1/FVC, MVV) on account of lower extremity exercise training for 6 weeks.
2) Group –B has significant changes on pulmonary function (FEV1, FVC, and FEV1/FVC, MVV) on account of upper extremity exercise training for 6 weeks.

Group –A and B have significant changes on pulmonary function (FEV1, FVC and FEV1/FVC, MVV) of 6 weeks training.

2. Material and Methods

2.1 Source of data:

Shri K. K. Sheth Physiotherapy College

2.2 Study design:

Experimental study design

2.3 Sampling technique

Simple random sampling

Duration of training:
5 days in a week for 6weeks.

2.4 Gender:

Female

2.5 Sample size

60 subjects were randomly selected from Shri K. K. Sheth physiotherapy college, Rajkot.

A written consent was taken from subjects participating in the study. (Annexture-1)

All the subjects' formal evaluation, pulmonary function test and physical activity readiness questioner were taken prior to study.[14]

Pulmonary function test was taken pre and post training as per the standard outlined by American Thoracic Society. Three trials were given to each subject and out of three trial best was selected.[15]

Subjects those are healthy in K. K. Sheth research center will participate in the study and subjects fulfilling the criteria were taken for the study.

2.6 Materials to be used:

1) Spirometer
2) Nose clip
3) Rope and pulley
4) Stop watch
5) Mouth piece
6) Weighing machine
7) Measure tape
8) Table
9) Pen
10) Paper
11) Spirit
12) Cotton
13) Plinth

2.7 Inclusion Criteria

1) Normal healthy individual.
2) Age: between 18 – 25 years.
3) Female
4) Body mass index: 18.5 – 25.kg/m^2

2.8 Exclusion Criteria

1) Subject with known case of musculo–skeletal problems.
2) Subject with Known case of any neurological disorder.
3) Subject with known case of pulmonary disease.
4) Subject with known case of peripheral vascular disease.
5) Athletes
6) Yes, to physical activity readiness questionnaire (PAR-Q)

Tools used for the study

PAR-Q (physical activity readiness questionnaire): -It has been designed to identify the physical activity should not pose any problem or hazard for adults. (Annexture-2)

PFT (pulmonary function test): - PFT is valuable tools for evaluating the respiratory system .it can be used to assess health status before enrollment in strenuous physical activity

Description of spirometer:
Spirometer is a device used to determine lung volumes and capacities. It comprises flash type sensor with a dismountable Circuit, pressure sensor, amplifier, voltage stabilizer and analogic to digital converter.

Spirometer circuit has been designed to order to consumer very little energy with the aim of working only with personal computer supply and therefore to autonomous.

The type of sensor and the quality of the analogic to digital converter influences the sharpness of its measurement. The system has the option of selecting best of three performances measured.

Validity for the spirometer was found from the different study and inter tester reliability was tested.

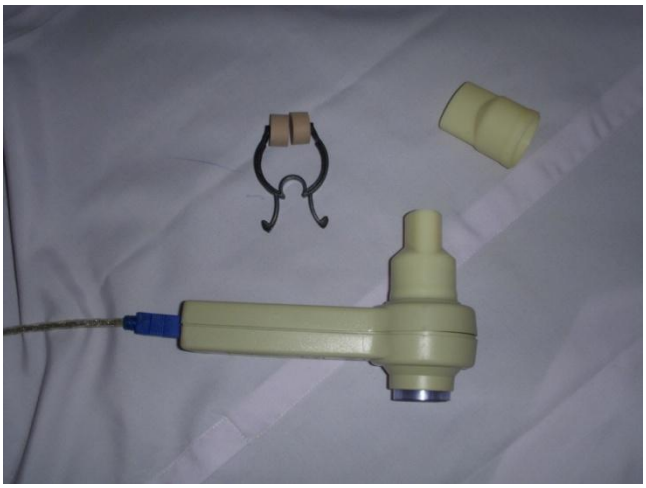


Figure: Spirometer Photograph

Examination:
The following information was recorded for each subject: - Name, age, sex, address, height, weight, BMI, any chest deformity, past history of respiratory illness, smoking status, PAR-Q and PFT.

Procedure of PFT:
PFT was taken by using RMS spirometer helios 401 and window version 2000 / XP.

Position of subject: comfortable high sitting position on table with foot placement on floor.

Subject was instructed to place the nose clip in position. Then place mouthpiece and breath into the sensor as prescribed.

Three trials were given and out of three best performances was taken into account.

1) Force vital capacity:
The subjects were asked to inspire the air then they were instructed to place mouthpiece correctly in mouth and immediately carry out forceful expiration and deep inspiration. FVC, FEV_1, FEV_1/FVC were attained from above maneuver.

2) Maximum voluntary ventilation (MVV):
The subject was instructed to position mouthpiece correctly in mouth and do rapid and deep breathing for 1 minute.
MVV were taken from above maneuver.

Figure: Flow volume loop and subject photograph

2.9 Procedure

60 normal healthy young women were randomly selected and study was explained to them then subjects were randomly assigned to two groups.

1) Group-A: 30 subjects had received upper extremity exercise training.
2) Group-B: 30 subjects had received lower extremity exercise training.

Subjects in both groups had received exercise training 5 days a week for 6 weeks.
In each group subject was given 10 minutes of general warm-up including stretching and mild intensity of exercise followed by 20 minutes exercise in coordination with respiration according to protocol and last 10 minutes of cool down.

Exercise Protocol:

Group-A (Upper extremity exercise training):[6]
1) Exercise on overhead pulley in sitting position
2) Push up
3) Shoulder abduction exercise in sitting position
4) Arm raise in quadruped position
5) Shoulder flexion extension exercise in sitting position

Group-B (Lower extremity exercise training):[16, 17]
1) Partial squats (do not bend knee more than 45 degree)
2) Forward lunges
3) Side lunges
4) Leg raise in quadruped position
5) Step up and down (height 6 inches)

Each exercise repeated for 45 seconds, followed by 15 second rest for 4 minutes. [4]

Training was terminated if subject experience dyspnea or fatigue.

3. Result

Statistical Analysis

Study design: Experimental study.
Test: The collected data were analyzed by paired t-test to compare the result within the group and unpaired t-test to compare the result between groups with 0.05 level of significant with 95% of confidence interval.

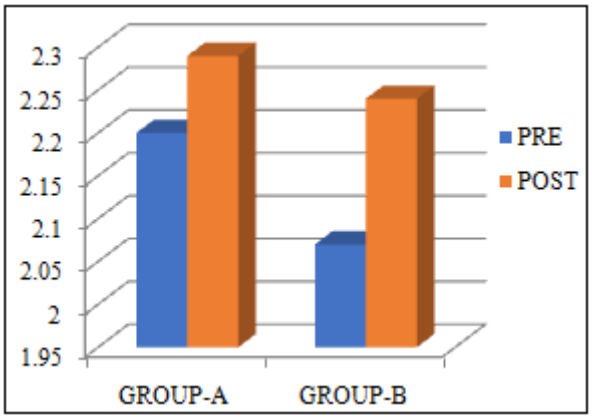
Table 1: Baseline data for demographic variable

Group	Group-A(UEET) Mean + SD	Group-B(LEET) Mean + SD
Number	30	30
Age in year	20 ±1	20±1
Body mass index	20.90±2.324	21.05±1.86

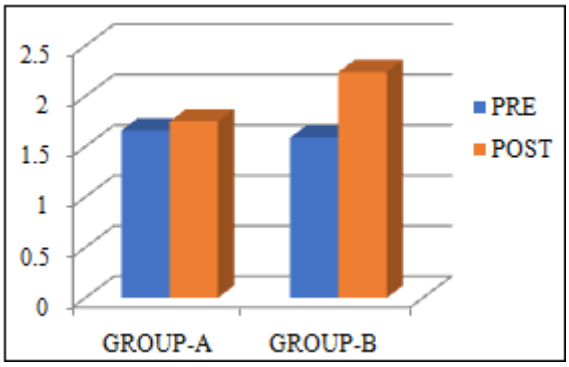
As per the table value comparison of groups at the baseline demographic data shows no significant difference in mean age and body mass index.

Table 2: Comparison of pre and post training PFT finding

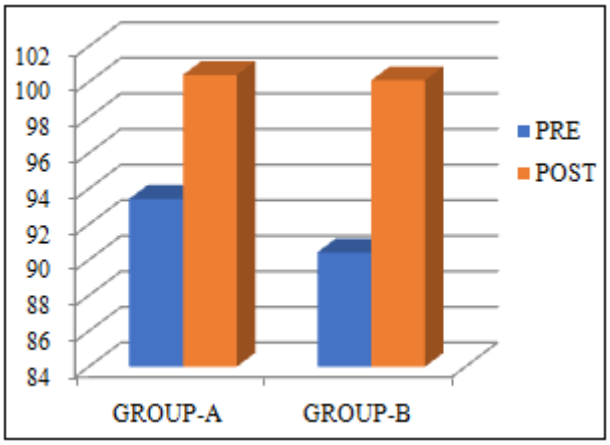
Group	A		B	
PFT	PRE-UEET (MEAN±SD)	POST-UEET (MEAN±SD)	PRE-LEET (MEAN±SD)	POST-LEET (MEAN±SD)
FVC	2.20±0.19	2.29±0.19	2.07±0.17	2.24±0.18
FEV_1	1.66±0.13	1.75±0.14	1.59±0.13	1.74±0.13
FEV_1 /FVC	75.84±3.60	76.59±3.41	77.03±2.10	77.61±2.02
MVV	93.43±17.42	100.40±16.62	90.43±11.78	100.10±9.17



Graph 1: Comparison of force vital capacity between Group–A and Group–B



Graph 2



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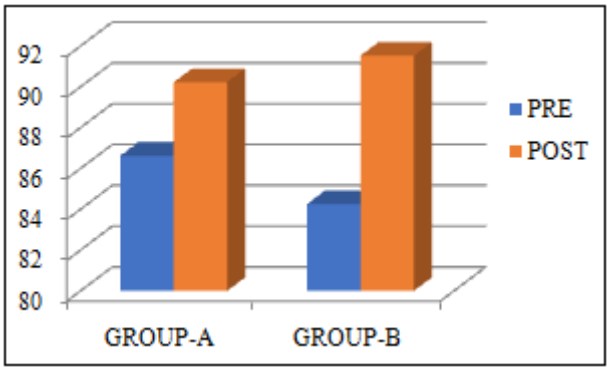

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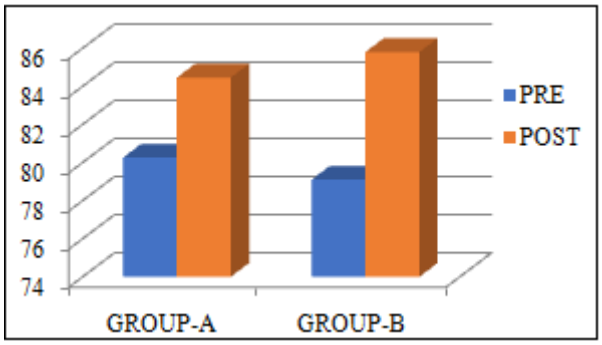
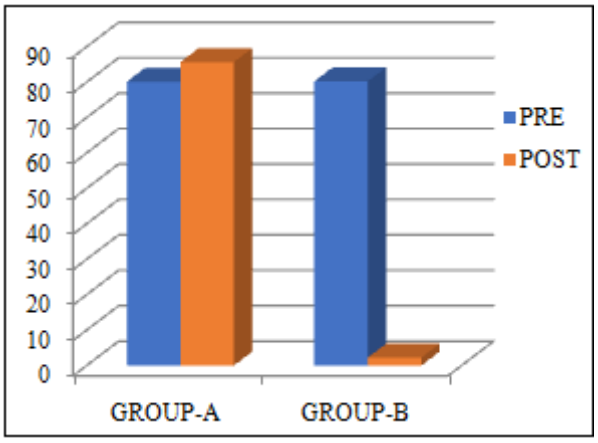


Graph 5



Graph 6

4. Discussion

From the above study, the alternate hypothesis is accepted and null hypothesis is rejected. Means both upper and lower extremity exercise training is effective to improve pulmonary function test. But lower extremity exercise training is better to improve PFT in short duration.

The baseline data of the demographic and outcome variable did not show any significant difference between the subjects in two groups indicating homogeneity of the subjects.

In Group–A, upper extremity exercise training had increased FVC, FEV_1, FEV_1/FVC, MVV. The present study showed an improvement in pulmonary function test which is in accordance with study done by Nici L, Donner C and Porta R and Couser JI, they found upper extremity training resulted in increase pulmonary function. This might be due to improved synchronization and co-ordination of accessory muscle action.[29, 31, 41]

Upper extremity muscles act as accessory muscle of respiration. During upper extremity exercise, the participation arm muscles in ventilation decrease and there is a shift of respiratory work to diaphragm. This is associated with thoracoabdominal dyssynchrony, severe dyspnea and termination of exercise at low workload than lower extremity exercise.[14]

The same guidelines given by Porta et al. and Stafinia costi postulated that the mechanism for improvement in respiratory function from such training include

desensitization to dyspnea, better muscular co-ordination and metabolic adaptation to exercise.[26, 31]

In the Group-B, after lower extremity exercise training had show an improvement in pulmonary function test. That was also supported by Dr. Pendergast, Lake FR and Aminoff T and concluded that lower extremity exercises are beneficial to improve pulmonary function.[29, 35, 37, 39] The improvement in pulmonary function after lower extremity exercise is mainly due to aerobic training effect and because of large muscle mass than upper extremity. So it requires more oxygen compare to arm muscle.[3]

So, both exercise training is beneficial to improve pulmonary function but, lower extremity exercises are better than upper extremity exercise to improve respiratory function in short duration.

Probable reason could be because of upper extremity muscle are working as accessory ventilator muscle. So, during upper extremity exercise they cannot work as a ventilator muscles. But, during lower extremity exercises upper extremity muscles are relax so they can more effectively work as a ventilator muscle.[3, 7]

Also, oxygen consumption during upper extremity exercise average 20 – 30% lowers than lower extremity exercise. similarly arm exercise produce lower maximal values for pulmonary ventilation. These differences relate to the relatively smaller muscle mass activated in arm exercise.[3]

All the domains of pulmonary function test were increase significantly pre and post training that might be because of aerobic training and improvement in respiratory muscle endurance.

So, our study is also in agreement with previous study suggesting that "lower extremity exercise training is more effective than upper extremity exercise in term of pulmonary function".

5. Limitations

1) Short duration of study.
2) Study is Limited for female subject.
3) Temperature was not maintained during training period and while taking PFT.

Clinical implication:
Results suggest that LEET are more beneficial to improve pulmonary function. So, this can be used for pulmonary disease patients to improve pulmonary function in early stage of exercise prescription and later on we can also include UEET for progression of exercise.

In acute or early stage of pulmonary disorder patient can go for UEET but in chronic or late stage of disease first give only LEET than go for UEET or avoid if patient become fatigue.

Further recommendation
1) HR, RR can be included in this study
2) Chest expansion can be measure in this study.

6. Conclusion

Upper extremity exercise training and lower extremity exercise training resulted in significant improvement in pulmonary function test (FVC, $FEV_{1,}$ MVV)

While efficacy of lower extremity exercise is higher over upper extremity exercise training in normal healthy young female for improvement of pulmonary function.

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