Original Research Article

Measurement and Correlation of FEV_1 and FVC with Muscular Endurance of Upper limbs in healthy adults

Viji Devanand [1], Lovie Beneta T [2], Buvana Arivazhaghan [3]

[1] Professor & Head, Department of Physiology ,[2] Associate Professor of Physiology, [3] Post Graduate, Department of Physiology, Stanley Medical College, Chennai, Tamil Nadu.

Abstract:

Background: Assessment of the strength of the skeletal muscles in the upper limbs can be done by endurance and resistance exercises. The exercise testing of muscular endurance of the upper limbs is a surrogate test for the efficiency of respiratory muscles. Muscular effort is inevitable for chest wall compliance and normal pulmonary function and good exercise capacity. Hence in this study the muscular endurance of the upper limbs assessed by Upper limb cycle ergometry is correlated with the FEV_1 and FVC measured by spirometry. **Aim:** To measure and correlate FEV_1 and FVC with the muscular endurance of the upper limbs in healthy adults. **Materials and methods**: An analytical cross sectional study was conducted among 54 healthy adults. Spirometry was done for 27 male and 27 female study participants and the percentage predicted values of FVC and FEV_1 were obtained. The muscular endurance of the upper limbs was assessed by the exercise duration in upper limb cycle ergometry. The data was analyzed using SPSS software and the Karl Pearson correlation was used to find out the correlation between spirometric indices and exercise duration. **Results:** The correlation of Percentage predicted FEV_1 and the exercise duration in the study participants was found to be high positive and statistically significant. ($r= 0.963$ $p< 0.01$) in females and ($r=0.986$ $p<0.01$) in male participants. The correlation of Percentage predicted FVC and exercise duration in the study participants was found to be high positive and statistically significant in males ($r=0.865$ $p< 0.01$) and low positive and statistically significant in females ($r = 0.391$ $p =0.043$). **Conclusion:** The correlation of the muscular endurance of the upper limbs and FEV_1 was found to be very high positive and statistically significant, suggesting that endurance training of the upper limbs in sedentary adults may improve their lung function and functional exercise capacity.

Keywords: exercise, forced expiratory volume, upper limb endurance training,

Corresponding Author:
Dr. Buvana Arivazhaghan, Post Graduate, Department of Physiology, Stanley Medical College, Chennai, Tamil Nadu.
Contact No. 8754573161, Email: dbhuvan.27@gmail.com

Introduction:

Airflow during forced expiration is influenced by elastic recoil of lung tissue, resistance of the upper airways and the strength of the respiratory muscles. Upper limb movements affect movements of chest and abdomen and thereby chest volume. Upper limb movements account for most of the activities of daily life. Endurance of upper limb muscles indirectly contributes to

dynamic lung functions by affecting the movement of chest wall and abdomen and the strength of respiratory muscles.

Isometric, Isotonic and Isokinetic exercise tests are used to assess the skeletal muscle function.[1,2,3,4] Isotonic exercise test bears the advantages of ease of operation of a simple unsophisticated device and hence used in this study.

Upper Limb cycle Ergometer (ULCE) has been validated to be used in the assessment of cardiorespiratory status of sedentary adults as an alternative to cycle ergometry. This widely suggests muscular endurance of the upper limbs as an important factor in lung functions and could be correlated with timed vital capacity.[5]

In comparison to other conventional physio therapeutical exercises, Upper limb cycle ergometry have effectively shown to increase muscle strength in the rehabilitation process.[6] Hence in this study muscular endurance of the upper limbs is assessed by the Upper limb cycle Ergometer. Also, the assessment of the muscular endurance of the upper limbs is more feasible than of the respiratory muscles and correlated with spirometric indices (FEV_1 and FVC) in the present study.

Aim and Objectives:

1. To measure FEV_1 and FVC in healthy adults by spirometry.
2. To assess the muscular endurance of the upper limbs by upper limb cycle ergometer (Isotonic exercise)
3. To correlate the measured spirometric indices with the muscular endurance of the upper limbs.

Materials and Methods:

This analytical cross-sectional study was conducted in the Department of Physiology, Government Stanley Medical College after obtaining Institutional ethical committee clearance, over a period of 2 months. 54 Healthy adults in the age group 18 – 45 years were recruited from the community using convenient sampling method based on the following criteria.

Inclusion Criteria:

1. Healthy male and female adults who gave consent for the study
2. Age group – 18 – 45 years

Exclusion Criteria:

1. Known case of Cardiovascular or Respiratory disorders including infections
2. Subjects on Bronchodilators
3. Known case of Systemic Hypertension and Diabetes mellitus
4. H/o syncope related to forced expiration or cough
5. Known case of CNS disorders with increased intracranial pressure
6. H/O surgeries in the past 1 month
7. Pregnancy
8. H/O motor impairment in the upper limbs

The participants of the study were explained thoroughly of the procedure and an informed consent was obtained. A detailed history was elicited and general and systemic examination was done for all the participants. Body mass index (BMI) was calculated for all the participants and the means were calculated for male and female participant groups in the study.

Spirometry was performed in ambient room temperature. The portable spirometer (Easy One, UK) was used to measure Forced Vital Capacity (FVC) in liters and Forced Expiratory Volume in 1st second (FEV_1) in liters and FEV_1/FVC ratio. The participant's age, height, weight, gender, ethnicity, smoker and asthma status were entered for each of them in the spirometer for the automated derivation of the predicted percentage of FEV_1 and FVC. The spirette was blocked for setting the baseline flow. A disposable mouthpiece with filter

was used for every participant. The participant was seated comfortably and was asked to inhale maximally after which they were instructed to place the mouthpiece in their mouth with the lips tightly sealed around it and with a nose clip on, the participant was encouraged to exhale out as hard and fast as possible till the timeline was shown to be completed in the spirometer. A minimum of three satisfactory trials were done at an interval of 2 minutes and the best of the values were noted down. The percentage predicted values of FEV_1 and FVC were noted down for all the study subjects.[7]

The Upper limb Cycle ergometer was used to assess the muscular endurance of the upper limbs. The device was placed at a suitable height to ensure the alignment of the ergometer's handle shaft and the center of the study participant's glenohumeral joint. Participant's sitting position was adjusted to ensure that their elbows were slightly bent and arms outstretched. Participants were instructed to maintain their feet flat on the floor all the time. The participants were encouraged to perform the cycling movement with their upper limbs and maintain the revolutions at 70/min.[5] There was no increment in resistance during the exercise session. The duration of the exercise was noted down for each participant and they were asked to stop if they felt pain in their arms.

Data collected were analyzed using IBM SPSS Software version 23. The continuous variables were expressed in mean and standard deviation. The categorical variables were expressed in frequency and percentage. Karl Pearson's correlation was used to determine the correlation of the endurance of the upper limb muscles and FVC, FEV_1 and FEV_1/FVC ratio. The test was considered significant if $p< 0.05$ at 95% confidence interval.

Results:

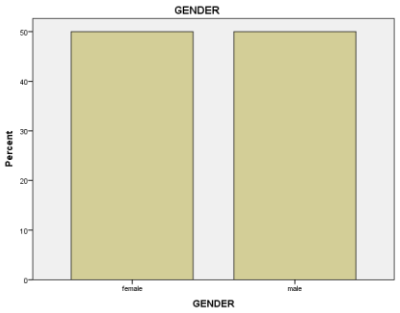
In the present study there were 27 male and 27 female participants with a mean age of 28.41 ± 9.08 years. As cited in Table.1Mean age among female participants was 32.93 ± 8. 03years.Mean age among male participants was 23.89 ± 7.83 years. The mean BMI among the male participants was 26.85 ± 8.9 and among the female participants was 26.528 ± 4.7. On analysis of BMI between male and female participant groups there was no statistically significant difference in means of BMI between groups (p value = 0.237). The mean value of Percentage predicted FEV_1 in female participants was 87.93 ± 12.14 % and Percentage predicted FVC was 95.56 ± 13.01 % and duration of exercise was 3.47 ± 1.32 minutes. The mean value of Percentage predicted FEV_1 in male participants was 99.63 ± 15.38 % and Percentage predicted FVC was 102.78 ± 15.96 % and the duration of exercise was 5.21 ±1.32 minutes.

As given in the Table.2 The Pearson product correlation of Percentage predicted FEV_1 and the exercise duration in the study participants was found to be very high positive and statistically significant. ($r= 0.963$ $p< 0.01$) in females and ($r=0.986$ $p<0.01$) in male participants.

The Pearson product correlation of Percentage predicted FVC and exercise duration in the study participants was found to be high positive and statistically significant in males ($r=0.865$ $p< 0.01$) and low positive and statistically significant in females ($r = 0.391$ $p =0.043$).

Table .3 shows The Pearson product correlation of FEV_1/FVC ratio and exercise duration in the study participants and was found to be very low positive and not significant ($r= 0.266$ $p>0.05$).

Graph 1: Distribution of gender among the study population



There were 27 female and 27 female participants in the study.

Table 1: Percentage Predicted FEV1 and FVC and Exercise duration in the study participants

Variable	N	Mean + SD	
		Females	Males
Age (years)	27	32.93 ± 8. 03	23.89 ± 7.83
BMI	27	26.528 ± 4.7.	26.85 ± 8.9
Percentage predicted FEV_1	27	87.93 ± 12.143	99.63 ±15.388
Percentage Predicted FVC	27	95.56±13.013	102.78 ±15.962
Exercise Duration in (min)	27	3.47 ±1.326	5.21±1.322

Table 2: Correlation of Percentage predicted FEV1 and FVC with Upper limb exercise duration in the study participants by Karl Pearson's Correlation test

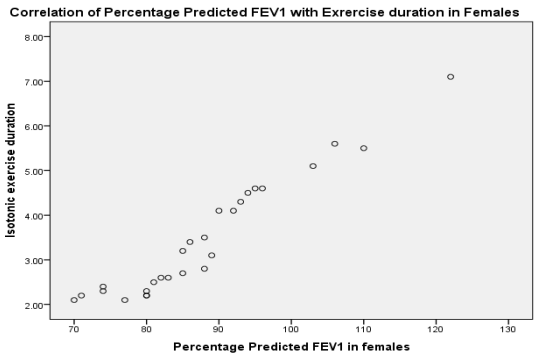
		Isotonic Exercise Duration
Percentage Predicted FEV_1 in Females	r- value	.963**
	p- value	.000
	N	27
Percentage Predicted FVC in Females	r- value	.391*
	p- value	.043
	N	27
Percentage Predicted FEV_1 in males	r- value	.986**
	p- value	.000
	N	27
Percentage Predicted FVC in males	r- value	.865**
	p- value	.000
	N	27

* Correlation is significant at the 0.05 level, **Correlation is significant at the 0.01 level

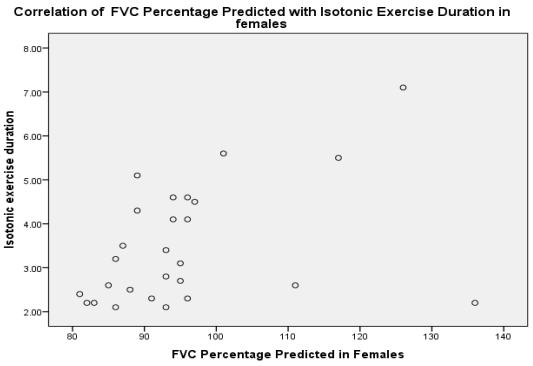
Table 3: Correlation of FEV_1/FVC ratio with Endurance Exercise Duration in the study participants

		Isotonic Exercise Duration
FEV1/FVC ratio	r- value	.266
	p- value	.052
	N	54

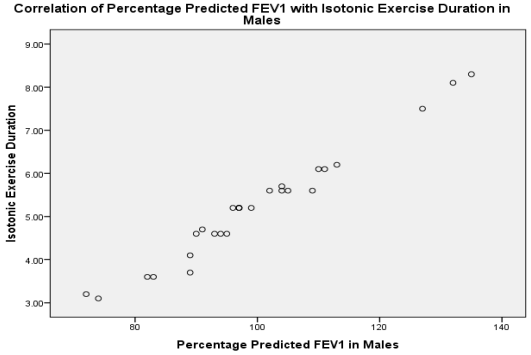
Graph 2:



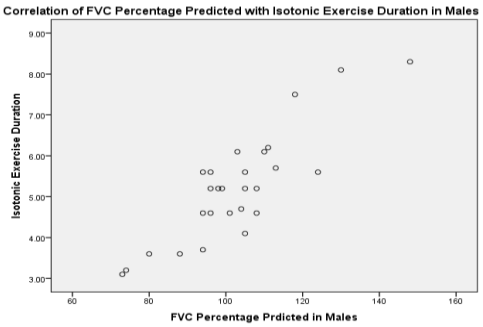
Graph 3:



Graph 4:



Graph 5:



Discussion:

The correlation of the respiratory function with muscular effort has been established by many studies. In the present study, the muscular endurance of the upper limbs indicated by the duration of exercise in the upper limb cycle ergometry had a very high positive correlation with the Percentage predicted Forced Expiratory Volume in 1st second (FEV_1) in both male and female participants who were not trained athletes. In accordance with the present study, study by Tarigan et al showed that upper limb endurance exercises showed positive correlation with improvement in FEV_1 and FVC.[8] Yekefallah et al showed that upper limb exercise leads to improvement in functional exercise capacity.[9]

The correlation of the muscular endurance of the upper limbs with Percentage Predicted Forced Vital Capacity (FVC) was found to be low positive in female participants of the study. In accordance with the present study results, study by Rawashde et al, concluded that aerobic exercise which increased the muscle endurance correlated with Forced Expiratory volume in 1 sec (FEV_1)but not significantly with Forced Vital capacity.[10]

In accordance with the findings of the present study, Kandakurti et al showed that there was a significant improvement in FEV_1 and FVC with upper limb isotonic exercise training .[11]

Conclusion:

A very high positive correlation of the muscular endurance of the upper limbs assessed by upper limb cycle ergometry with the FEV_1 in the present study suggests that endurance training of the upper limbs may show improvement in the pulmonary function and functional exercise capacity in sedentary young healthy adults.

Limitations:

Respiratory muscle strength assessed by Maximal Inspiratory Pressure (MIP) and Maximal Expiratory Pressure (MEP) will be more specific than FEV_1 and FVC

Acknowledgements: Nil

Conflict of interest: Nil

References:

1. Cronin J, Lawton T, Harris N, Kilding A, McMaster DT. A Brief Review of Handgrip Strength and Sport Performance. Journal of Strength and Conditioning Research. 2017 Nov;31(11):3187–217.
2. Kaymaz D, Candemir İÇ, Ergün P, Demir N, Taşdemir F, Demir P. Relation between upper-limb muscle strength with exercise capacity, quality of life and dyspnea in

patients with severe chronic obstructive pulmonary disease. Clin Respir J. 2018 Mar;12(3):1257–63.

3. Liu X, Li P, Wang Z, Lu Y, Li N, Xiao L, et al. Evaluation of isokinetic muscle strength of upper limb and the relationship with pulmonary function and respiratory muscle strength in stable COPD patients. COPD. 2019 Sep; Volume 14:2027–36.
4. Toosizadeh N, Berry C, Bime C, Najafi B, Kraft M, Mohler J. Assessing upper-extremity motion: An innovative method to quantify functional capacity in patients with chronic obstructive pulmonary disease. Chotirmall SH, editor. PLoS ONE. 2017 Feb 24;12(2): e0172766.
5. Mitropoulos A, Gumber A, Crank H, Klonizakis M. Validation of an Arm Crank Ergometer Test for Use in Sedentary Adults. J Sports Sci Med. 2017 Dec;16(4):558–64.
6. da Rosa Pinheiro DR, Cabeleira MEP, da Campo LA, Gattino LAF, de Souza KS, Dos Santos Burg L, et al. Upper limbs cycle ergometer increases muscle strength, trunk control and independence of acute stroke subjects: A randomized clinical trial. NeuroRehabilitation. 2021;48(4):533–42.
7. Graham BL, Steenburgen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. Am J Respir Crit Care Med. 2019 Oct 15;200(8): e70–88.
8. Tarigan AP, Ananda FR, Pandia P, Sinaga BY, Maryaningsih M, Anggriani A. The The Impact of Upper Limb Training with Breathing Maneuver in Lung Function, Functional Capacity, Dyspnea Scale, and Quality of Life in Patient with Stable Chronic Obstructive of Lung Disease. Open Access Maced J Med Sci. 2019 Feb 25;7(4):567–72.
9. Yekefallah L, Zohal M, Keshavarzsarkar O, Barikani A, Gheraati M. Comparing the Effects of Upper Limb and Breathing Exercises on Six-Minute Walking Distance among Patients with Chronic Obstructive Pulmonary Disease: A Three-Group Randomized Controlled Clinical Trial. Advances in Respiratory Medicine. 2019 Apr 2;87(2):77–82.
10. Rawashdeh A, Alnawaiseh N. The Effect of High-Intensity Aerobic Exercise on the Pulmonary Function among Inactive Male Individuals. Biomed Pharmacol J. 2018 Jun 28;11(2):735–41.
11. Kandakurti, Praveen & Alagesan, Jagatheesan & Gopal, Kumaraguruparan & Jebasingh, Kishore & Kameswaran, Ramana. (2021). Efficacy of upper extremity exercise training on pulmonary functions in people with chronic obstructive pulmonary disease. Türk Fizyoterapi ve Rehabilitasyon Dergisi/Turkish Journal of Physiotherapy and Rehabilitation. 32. 466.