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A STUDY TO CORRELATE PULMONARY FUNCTION TEST AND MAXIMUM OXYGEN CONSUMPTION IN HEALTHY YOUNG ADULTS

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Relevance. Pulmonary function test (PFT) is an important assessment for lung function. The most commonly used method for PFT is Spirometry. It involves the use of a spirometer to measure lung volumes and capacities. Different diseases cause different patterns of abnormalities in a battery of pulmonary function tests. An earlier study suggested that reductions in maximal oxygen consumption (VO_2 max) occur reasonably among patients of obstructive and restrictive lung diseases.

Objective of this study was to assess the correlation between the parameters of pulmonary function and cardio-respiratory fitness with the amount of physical activity.

Material and Methods. This pilot study was conducted in the Department of Physiology, RUHS College of Medical Sciences, in a group of 100 apparently healthy subjects (students) of 18-25 years age group of either sex. Anthropometric parameters (height, weight and BMI), pulmonary function test (PFT), GPAQ, body fat percentage and VO_2 max were assessed in standard laboratory settings.

Results. The mean±SD for Age, Height, Weight, GPAQ score, FEV_1, PEFR, MVV, FEF25-75% and VO_2 max was found to be higher in male participants as compared to female participants while BMI and FVC were almost equal in both the genders but Body Fat % and FEV_1/FVC were higher in female participants. Correlation of VO_2 max with FVC, FEV_1. PEFR, MVV and FEF25-75% is moderately positive while correlation of VO_2 max with FEV_1/FVC is poorly negative in male subjects. In female subjects correlation of VO_2 max with FVC, FEV_1. PEFR and MVV is poorly positive while with FEV_1/FVC and FEF25-75% it is poorly negative.

Conclusion. Present study concludes that maximum oxygen consumption (VO_2 max) was positively correlated with pulmonary functions except FEV_1/FVC ratio in male. While it was poor positive in females except FEV_1/FVC ratio and FEF. Study also concludes that observations of PFT parameters vary for male and female subjects. VO_2 max i.e. maximum Oxygen Consumption was found to be higher in male participants of the study as compared to female participant's i.e. male subjects utilizes more amount of Oxygen while exercising than female subjects.

Keywords: Pulmonary Function Test, Maximum Oxygen Consumption, Spirometry, Respiratory System.

Relevance. Pulmonary function test (PFT) is an important assessment for lung function [1]. Permit accurate, reproducible assessment of the functional state of the respiratory system. Different diseases cause different patterns of abnormalities in a battery of pulmonary function tests. These patterns allow us to quantify the severity of respiratory disease, which enables us to detect disease early and characterize the natural history and response to treatment [2].

The most commonly used method for PFT is Spirometry. It involves the use of a spirometer to measure lung volumes and capacities. Spirometer is basically of two types, simple and computerized. But the drawback with the simple spirometer is that it can't measure the values of dynamic lung indices [3].

Computerized spirometer is used to measure dynamic lung volumes and capacities, which is reported graphically depicting volumes and flow patterns in the lungs. The most important parameters in dynamic spirometry are the FVC, FEV_1 and the FEV_1/FVC ratio [4].

Earlier studies show that the Variables of Spirometry (FVC, FEV_1 & FEV_1/FVC ratio) have a close interaction with higher VO_2 max levels [5].

An earlier study suggested that reductions in maximal oxygen consumption (VO_2 max)occur reasonably among patients of obstructive and restrictive lung diseases [6].

VO_2 max is maximal oxygen consumption i.e. the maximum amount of oxygen a person can take in and the value does not change despite an increase in workload overtime until voluntarily exhaustion. VO_2 max is the primary measure of cardio respiratory fitness [7].

VO_2 max can be estimated using direct or indirect methods. Direct method also known as maximal graded exercise test can be estimated by open circuit Spirometry, which is generally used in clinical or

research settings e.g. Treadmill test, cycle ergometry. An indirect method of calculating VO_2 max is exercise based and non-exercise based. Exercise based VO_2 max is calculated by equations such as queen's college step test, cooper 12 min test,1 mile rock port test etc. while Non exercise based VO_2 max is estimated by age, body surface area, body mass index, fat % e.g. Wassermann equation [8].

People who possess a low VO_2 max have an increased chance of premature death, as well as the development of numerous chronic diseases, whereas individuals with a high VO_2 max have less chance of developing chronic diseases, all-cause mortality, and coronary artery disease [9].

A dynamic lung volume is the basic component of cardiopulmonary fitness (VO_2 max) itself, however their correlation with each other and with physical activity level is to be investigated further.

Objective of this study is to assess the correlation between the parameters of pulmonary function and cardio-respiratory fitness with the amount of physical activity.

MATERIAL AND METHODS

A Pilot study was conducted in the Department of Physiology, RUHS College of Medical Sciences, Jaipur in a group of 100 apparently healthy subjects (students) of 18-25 years age group of either sex from RUHS college of Medical Sciences by Convenient sampling. Ethical approval (EC/P-35/2019) was taken for this research from institutional ethical committee of RUHS College of medical sciences, Jaipur. And written informed consent was collected from all the participants (Voluntary). Study Design was Cross sectional study. The subjects suffering from Hypertension, Diabetes, Cardiac, Respiratory and Musculo-skeletal disorders having history of hospitalization in last three months and use of alcohol and smoking were excluded from study.

The anthropometric assessment was done as per the guidelines given in the Anthropometry Procedures Manual published by the National Health and Nutrition Examination Survey (NHANES) [10].

All measurements were taken prior to the start of the exercise schedule.

Weight and height were measured with help of standardized weighing machine and stadiometer

Body fat Percentage was estimated according to chart based on Durnin and Womersley data (1974) [11].

Global physical activity questionnaire (GPAQ):

This questionnaire collects information on physical activity participation in three settings(domains): activity at work (work or occupational physical activity), travel to and from places (active travel), and on leisure time physical activity (recreational physical activity), as well as sedentary behaviour.

Pulmonary Function Test was performed using computerized Spirometry (model no: CMSP-01). The measurements taken under dynamic lung indices were FVC, FEV1, and FEV1/FVC%.

VO_2 max was measured using direct method AD Instrument Gas Analyser (model-ML206).The test procedure "The treadmill graded exercise test protocol", in which Subject is asked to walk for 3 minutes at level grade followed by a brisk walk at self-selected speed (b/w 4.3-7.5 mph)at level grade for 3 minutes and then with a constant speed, treadmill grade is increased by 2.5% every minute until the subject achieves fatigue and is unable to continue the exercise [12].

RESULTS AND DISCUSSION

Table 1 mentioned above shows that mean±SD for Age, Height, Weight, GPAQ score, FEV_1, PEFR, MVV, FEF25-75% and VO_2 max was found to be higher in male participants as compared to female participants while BMI and FVC were almost equal in both the genders but Body Fat % and FEV_1/FVC were higher in female participants.

Table 2 shows the correlation of VO_2 max with parameters of PFT i.e. FVC, FEV_1, FEV_1/FVC ratio, PEFR, MVV and FEF25-75% in male and female subjects. According to the table mentioned above correlation of VO_2 max with FVC, FEV_1. PEFR, MVV and FEF25-75% is moderately positive while correlation of VO_2 max with FEV_1/FVC is poorly negative in male subjects. In female subjects correlation of VO_2 max with FVC, FEV_1. PEFR and MVV is poorly positive while with FEV_1/FVC and FEF25-75% it is poorly negative.

The present Pilot study was done toassess the correlation of maximal oxygen consumption VO_2 max with parameters of pulmonary function test in healthy young adults.

Mean FEV_1/FVC ratio of male subjects under the study was 89.73±7.1 and for female subjects it was 91.48±4.7. While FEV_1/FVC ratio for males and females in the study by Vijyan VK was 85.87±7.05 and 87.53±6.17 respectively. This shows that in both males and females of present study value of FEV_1/FVC ratio were slightly higher than that in Vijyan's study, but difference is very minor or ignorable [13].

Mean PEFR of male and female subjects under the study was 5.20±1.75 and 3.97±1.43 L/min. These values of PEFR were found to be lesser than that

Table 1

Distribution of mean±SD of different parameters in total subjects (male & female) Age, Height, Weight, BMI, Body Fat%, GPAQ Score, FVC, FEV_1, FEV_1/FVC, PEFR, MVV, FEF25-75% and VO_2 max

№	Parameters	Male subjects mean±SD	Female subjects mean±SD	t-value	p-value
1	Age	19.88±1.8	19.02±1.6	1.125	0.131
2	Height	1.68±0.05	1.59±0.05	11.048	0.001
3	Weight	64.26±10.35	54.42±9.2	4.262	0.002
4	BMI	21.47±3.09	21.53±4.7	-0.08	0.46
5	Body FAT %	14.53±3.53	21.09±5.4	-6.935	0.001
6	GPAQ SCORE	1538.35±616.2	957.85±321.75	4.686	0.001
7	FVC (L)	2.77±0.73	2.7±0.46	4.764	0.001
8	FEV_1 (L)	2.45±0.62	1.84±0.4	4.81	0.001
9	FEV_1/FVC	89.73±7.1	91.48±4.7	-1.185	0.119
10	PEFR (L/min)	5.20±1.75	3.97±1.43	3.263	0.007
11	MVV (L)	102.36±33.55	78.95±23.8	-16.293	0.001
12	FEF25-75%	3.3±0.97	2.7±0.67	2.943	0.002
13	VO_2 max	46.83±9.48	35.94±9.8	5.618	0.001

Note:
GPAQ – Global Physical Activity Questionnaire Score;
FVC – Forced Vital Capacity;
FEV_1 – Forced Expiratory Volume in 1 Second;
FEV_1/FVC – Forced Expiratory Volume in 1 Second to Forced Vital Capacity Ratio;
PEFR – Peak Expiratory Flow Rate;
MVV – Maximum Voluntary Ventilation;
FEF 25-75% – Forced Expiratory Flow Over the Middle One-Half of the FVC;
VO_2 max – Maximum Oxygen Consumption.

Table 2

Distribution of correlation of VO_2 max with PFT parameters in male and female subjects

№	Parameters	r- male	p-value	r- female	p-value
1	VO_2 max & FVC	0.66	<0.001	0.168	0.37
2	VO_2 max & FEV1	0.70	<0.001	0.130	<0.493
3	VO_2 max & FEV_1/ FVC	-0.013	0.91	-0.139	0.463
4	VO_2 max & PEFR	0.48	<0.01	0.16	0.38
5	VO_2 max & MVV	0.55	<0.01	0.24	0.18
6	VO_2 max & FEF	0.48	<0.01	-0.059	0.75

found in another study conducted by Nayak PK et al. in which PEFR of male and females subjects was 8.95±1.12 and 7.01±1.07 L/min respecitively [14]. As PEFR is affected by several factors like age, height, weight, BMI etc. Thus difference in these anthropmetric parameters could be a reason of causing difference between the PEFR of subjects from two studies.

Mean MVV of male and female subjects under the present study was 102.36±33.55 and 78.95±23.8 L. Values were found to be higher than observed by Solanki S et al. in their study conducted on healthy young adults from population of western rajasthan. The values of MVV in their study for male and female participants were 70.41±33.57 and 52.23±24.71 L respectively. A significant difference between the MVV of male and female participants was observed in both the studies [14].

Values of FEF25-75% for male and female participants under our study were 3.3±0.97 and 2.7±0.67 respectively. It shows that male participants were having higher FEF25-75% than female participants, may be because of difference in size of thoracic cage and anthropometric measurements. Similar findings occurred in the study conducted by Vijayan VK et al. In their study FEF25-75% for male and female subjects was 4.16±1.28 and 2.77±0.76 i.e. females were having slightly lesser values of this parameters.

Mean VO_2 max of male and female subjects under the study was 46.83±9.48 and 35.94±9.8 ml/kg/min respectively. In the present study male participants were having higher VO_2 max level than the female participants of our study. Similar results were found in another study conducted in Gujrat by Shah H et al. on healthy young population in which mean VO_2 max of was 36.12±12.05 ml/kg/min, while that for male and female subjects was 39.5±11.28 and 32.74±12.82 ml/kg/min. Observations under present was slightly higher than that found in the study by shah but the difference occurred between male and female participants were found in both the studies [15].

Correlation between VO_2 max and PFT parameters was evaluated separately for male and female participants in the present study. In male participants, VO_2 max was found to be correlated moderately positive with FVC (r=0.66) and FEV_1 (r=0.70). VO_2 max of male participants was poorly positive for PEFR (r=0.48), MVV (r=0.55), FEF (r=0.48), on the other hand correlation was poorly negative with FEV_1/FVC ratio (r=-0.013). In the female participants of our study, VO_2 max was correlated poorly positive with FVC (r=0.168), FEV_1 (r=0.13), PEFR (r=0.16) and MVV (r=0.24). VO_2 max of female subjects was correlated poorly negative with FEV_1/FVC ratio (r=0.139) and FEF (r=0.059).

CONCLUSION

Present study concludes that maximum oxygen consumption (VO_2 max) was positively correlated with pulmonary functions except FEV_1/FVC ratio in male. While it was poor positive in females except FEV_1/FVC ratio and FEF. Study also concludes that observations of PFT parameters vary for male and female subjects. VO_2 max i.e. maximum Oxygen Consumption was found to be higher in male participants of the study as compared to female participant's i.e. male subjects utilizes more amount of Oxygen while exercising than female subjects.

Author contributions. Soni H. – research concept, data collection; Kacker S. – Analysis of data obtained; Saboo N. – Entry of the data obtained, Analysis of data obtained; Sorout J. – text writing. Each author contributed personally to the interpretation of the data. All authors read and approved the final manuscript.

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Limitations: It was a pilot study with a less sample size.

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ДОСЛІДЖЕННЯ МЕТОДУ КОРЕЛЯЦІЇ ТЕСТУ НА ЛЕГЕНЕВУ ФУНКЦІЮ ТА МАКСИМАЛЬНОГО СПОЖИВАННЯ КИСНЮ У ЗДОРОВИХ МОЛОДИХ ЛЮДЕЙ

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Актуальність. Тест легеневої функції (ТЛФ) є важливим для оцінки функції легенів. Найбільш поширеним методом ТЛФ є спірометрія. Він передбачає використання спірометра для вимірювання об'єму та ємності легень. Різні захворювання спричиняють різні моделі аномалій у тестах легеневої функції. Попереднє дослідження показало, що зниження максимального споживання кисню (VO_2 max) обґрунтовано відбувається серед пацієнтів з обструктивними та рестриктивними захворюваннями легень.

Ціль: оцінити кореляцію параметрів легеневої функції та кардіореспіраторної підготовленості з обсягом фізичного навантаження.

Матеріали та методи. Це пілотне дослідження було проведено на кафедрі фізіології коледжу медичних наук RUHS, у групі зі 100 практично здорових суб'єктів (студентів) віком 18-25 років будь-якої статі. Антропометричні параметри (зріст, вага та IMT), легенева функція (ТЛФ), GPAQ, відсоток жиру в організмі та VO_2 max були оцінені в стандартних лабораторних умовах.

Результати. Було виявлено, що середнє значення±SD для віку, зросту, ваги, оцінки GPAQ, FEV_1, PEFR, MVV, FEF25-75 % і VO_2 max було вищим у чоловіків-учасників порівняно з жінками, тоді як IMT і ФЖЕЛ були майже однаковими в обох статей. Але % жиру в організмі та FEV_1/FVC були вищими у жінок-учасниць. Кореляції VO_2 max з FVC, FEV_1, PEFR, MVV і FEF25-75 % є помірно позитивними, тоді як кореляція VO_2 max з FEV_1/FVC слабо негативна у чоловіків. У жінок кореляція VO_2 max з FVC, FEV_1, PEFR і MVV слабо позитивні, тоді як з FEV_1/FVC і FEF25-75% слабо негативні.

Висновок. Максимальне споживання кисню позитивно корелює з легеневими функціями, за винятком співвідношення FEV_1/FVC у чоловіків. У жінок показник слабо позитивний, за винятком співвідношення FEV_1/FVC і FEF. Параметри ТЛФ відрізняються для чоловіків і жінок. Максимальне споживання кисню вище у чоловіків, порівняно з жінками, тобто чоловіки споживають більше кисню під час тренування, ніж жінки.

Ключові слова: легенева функція, максимальне споживання кисню, спірометрія, дихальна система.