

Original research article

Association of Aerobic capacity and pulmonary function tests among first-year medical students: A cross sectional study¹Shah Helly, ²Charushila Rukadikar¹2nd Year MBBS student ZMCH, Dahod, Gujarat.²Assistant professor, Department of Physiology, ZMCH, Dahod.**Corresponding Author: Charushila Rukadikar****Abstract**

Background: Aerobic capacity depends on two factors one is the cardiac output and another one is the ventilatory capacity of the lungs, both of which are affected by exercise. Cardiopulmonary endurance requires a synchronized work between circulatory and respiratory systems.

Aim and Objectives: To study the cardiopulmonary health of students. To study the correlation between VO₂ Max with PFT among first-year MBBS students. To study comparison of PFT, VO₂ Max, & BMI in male & female first-year MBBS students.

Material and Methods: BMI was calculated using a weighing machine for weight and a stadiometer for height with the formula, BMI = weight/height², the respiratory function was assessed by PFT. Aerobic capacity was calculated by Astrand 6-minute Cycle Test. Statistical analysis was done by unpaired t-test & Pearson correlation coefficient.

Results: There has been a positive association between FVC, FEV₁, FEV₂₅₋₇₅, SVC, ERV, MVV, PEFr, LUNG Age, and VO₂ Max. Statistically there was a significant difference observed in FVC, FEV₁, FEV₂₅₋₇₅, PEFr, SVC & statistically, there is no significant difference observed in ERV, lung age, BMI, VO₂ Max between Male and female first-year MBBS students

Conclusion: Due to decreased physical activity, unhealthy lifestyle, overweight, and obesity, medical students are more prone to cardiopulmonary diseases. So, making them aware by doing simple tests and taking simple measures for a healthy lifestyle can prevent further complications.

Keywords: Cardiopulmonary endurance, PFT, Aerobic capacity, VO₂ Max.

Introduction

Cardiopulmonary endurance is defined as the ability of the circulatory system, respiration, and muscles to deliver oxygen and nutrients, efficiently into cells through the bloodstream during constant physical activity.¹ The gold standard of cardiopulmonary and muscle cell fitness is known to be maximum oxygen intake. VO₂ max is the maximum volume of oxygen consumed in one minute during maximal exercise which shows cardiorespiratory endurance of an individual as an aerobic fitness parameter.² The measurement of VO₂ max is useful while educating individuals about their overall fitness status, considering cardiovascular risk.³

VO₂ max depends on two factors one is the cardiac output and another one is the ventilatory capacity of the lungs, both of which are affected by exercise.⁴ It is believed that normal, young subjects have a large ventilator reserve and that maximal exercise capacity in this population is due to cardiovascular limitation. Reduced VR is considered indicative of ventilatory limitation.⁵ Although, normal dynamic lung volume is not the primary limiting factor of peak VO₂, it has recently been found that FEV₁ above the lower limit of normal is

positively correlated with peak VO_2 in healthy elderly subjects.⁶

The basic component of cardiopulmonary endurance itself is lung function. Lung function at a young adult age can predict airway obstruction in 20 years ahead.⁷ A new international study reported airway obstruction in almost 4% of young adults aged 20-44 years in recent years.⁸ Lung function is associated with respiratory processes, one of them is pulmonary ventilation. To keep the bodywork normally, it takes the optimal work of the heart and lungs.⁹ Cardiopulmonary endurance requires a synchronized work between circulatory and respiratory systems. One of the simple and important measures for the diagnosis and evaluation of pulmonary status is the pulmonary function test.¹⁰ Pulmonary function tests give readings of FVC, FEV₁, FEV₂₅₋₇₅, SVC, ERV, MVV, PEF, Lung Age.

As per some research, Females have lower values for lung function parameters as their respiratory muscle endurance, and chest wall compliance is lower than males.¹¹ In addition to the anatomical and physiological variations, the gender disparity in lung function can also be responsible for many other causes, such as sex hormones, sex hormone receptors, or intracellular signaling pathways.^{12,13} This can be because, as opposed to females, men have larger lungs at the same height. Another contributing factor could be the greater strength of respiratory muscles in males.¹⁴ So, we planned to evaluate the gender differences between these parameters.

This study found a correlation of PFT and VO_2 max & gender wise difference in above-mentioned parameters. Subjects for this research were Zydus Medical College 1st year MBBS students, Dahod, Gujarat. Due to decreased physical activity, an unhealthy lifestyle, overweight, and obesity, medical students are more prone to cardiopulmonary diseases. But it will avoid further problems by making them conscious by doing simple tests and taking simple steps for a healthier lifestyle. The advantage of this study is use of this data for making normative data for PFT, VO_2 Max in further studies.

Material and Methods

A descriptive cross-sectional study was done in Zydus Medical College, Gujarat. Inclusion criteria were Normal healthy first-year MBBS students between 18-21 years of age with informed consent and who were free from cardiopulmonary disease. Subject age group below 18 years & above 21 years, s having a history of smoking, tobacco chewing & alcohol consumption, had a past history of major respiratory or cardiovascular illness, who were on regular medication affecting the cardiopulmonary system were excluded

The current research was carried out in the Department of Physiology's clinical physiology laboratory & authorized by the Ethical Committee of the Institution. Duration of the study was April 2019- October 2019. The verbal and visual screening was done for selection and subjects were informed about the study in the local language (Gujarati). A brief explanation of the procedure to the subjects and the demonstration of what is being tested were also given.

Total 167 students divided into male group and female group on the basis of gender for gender-wise comparison of parameters in groups. VO_2 Max calculated by Astrand 6-minute Cycle Test. Subject instructed for warm up for 10 minutes after the demonstration. Cycle revolution were as per the weight. For weight 35, male cycle work rate 125, female cycle work rate 115. For weight 35-55 male cycle work rate 115, female cycle work rate 85. For weight over 55, male cycle work rate 85, female cycle work rate 60. This setting raised subjects heart rate to 130-160bpm after 2 minutes of cycling at 60rpm. We had given command "GO" and started stopwatch and subject had pedals at 60rpm for 6 minutes whilst maintaining their heart rate between 130-160bpm. We had recorded the subject heart rate each minute. After 2 minutes - if the subject heart rate is not in the target range of 130-160bpm then we had adjusted the work rate wattage accordingly. Then we stopped the test

after 6 minutes and recorded the final work rate wattage. Assessment done by following the calculator utilized a series of polynomial equations based on the Astrand-Ryhming Nomogram (Astrand 1954).¹⁵To obtain an estimate of VO_2 (L) and VO_2 max (ml/kg/min) we entered gender, weight, pulse rate, and work rate (kg-m/min).

For PFT, We had a fixed transducer first into transducer assembly. Then we used a nose clip to allow air to flow only through the subject mouth and ensured that the subject is standing upright and his clothes, fingers, etc. were not obstructing airflow. We pressed the start icon. Performed maneuvers per required test like FVC/SVC/MVV which were explained below & then pressed stop icon. After the maneuver is performed display screen will show the graph obtained and the results were printed from the printer. We instructed the subject to take first breathe in deeply to the full extent for measuring Forced Vital Capacity (FVC):. The subject then placed transducer to mouth and expelled air in their lungs quickly Once all air in the lungs is expelled, the subject told to must breathe in quickly still with a transducer to mouth, until the lungs were full. For measuring Slow Vital Capacity (SVC), we instructed the subject to breathe regularly through a mouthpiece. We instructed them to take a deep breath followed by deep exhalation. Both inhalation and exhalation were performed to the maximum extent. After this slow maneuver subject was asked to take a few gentle and normal breaths. We instructed subjects to breathe deeply and quickly through the mouthpiece for 15 seconds constantly for the measurement of maximal Ventilatory Volume (MVV):

Pearson correlation coefficient used for correlation in between parameters. For comparison of parameters, the t-test was applied. All statistical calculations and analyses were performed using version 16.0 of SPSS for Windows (Social Sciences Statistical Package) program.

Observation and Results

Table 1: Correlation between VO_2 Max with PFT In first-year MBBS Students

Parameters	FVC	FEV ₁	FEF ₂₅₋₇₅	PEFR	Lung Age	SVC	ERV	MVV
Correlation coefficient (r)	0.27	0.27	0.05	0.12	0.09	0.34	0.10	0.10

Among first-year MBBS students, there was a positive association between VO_2 Max and FVC, FEV₁, FEV₂₅₋₇₅, SVC, ERV, MVV, PEFR, LUNG Age.

Table 2: Comparison of PFT, VO_2 MAX, & BMI in Male & Female first-year MBBS Students

Parameters	Male (N = 61)		Female (N = 106)		t- value	p- Value
	Mean	S.D	Mean	S.D		
FVC	2.750	0.585	2.243	0.671	5.146	0.00*
FEV ₁	2.750	0.585	2.234	0.644	5.372	0.00*
FVC/FEV ₁	99.95	0.219	99.41	1.871	2.500	0.13
FEF ₂₅₋₇₅	5.1587	0.989	3.982	1.025	7.505	0.00*
PEFR	6.020	1.315	4.837	1.414	5.556	0.00*
SVC	3.424	0.712	2.723	0.694	6.424	0.00*
ERV	0.862	0.640	0.727	0.684	1.309	0.192
BMI	23.85	5.072	23.43	4.582	5.993	0.575
VO_2 Max	32.62	14.30	32.01	16.50	0.249	0.803

*Statistically significant (p < 0.05)

Statistically, there was a significant difference observed in FVC, FEV₁, FEF₂₅₋₇₅, PEFR, SVC

between Male and female first-year MBBS students ($p < 0.05$). Statistically, there is no significant difference observed in FVC/FEV₁, ERV, lung age, BMI, VO₂ Max between Male and female first-year MBBS students ($p > 0.05$).

Discussion

Regarding the correlation of VO₂ MAX & PFT

There was a positive correlation between VO₂ Max with FVC, FEV₁, FEV₂₅₋₇₅, SVC, ERV, MVV, PEFR, LUNG Age (Table 1). The circulation system components such as oxygen-carrying capacity, the heart pumps, and the use of oxygen in the muscle might have a greater influence on the VO₂ Max.¹Based on Doewes¹⁶ research about the most dominant contribution factor of body systems to physical fitness, it is said that the respiratory system only contributed the effective contribution of 12.32% compared to 36.97% for the cardiovascular system and 49.29% for oxygen carrier systems.

Physical activity enhances the cardiovascular and locomotor systems' ability to carry and use oxygen, although there is no direct impact on the respiratory system. Consequently, an improvement in the maximum function of the circulatory and muscular systems from exercise will increase the demand for oxygen transport in the respiratory system, thus reducing any spare capacity of this system.

A similar result with our finding i.e. FEV₁ is positively correlated with VO₂ Max is shown by Erlend Hassel⁶ Tony G. Babb¹⁷, Øystein Rasch-Halvorsen¹⁸. The dissimilar result with our Siti Khadijah Rahmania¹⁹ who stated that there was no significant correlation between FEV₁ with the VO₂ max of the respondents. It may be because of other several factors affecting VO₂ Max like the physical factors (age, height, weight, sex, and body size), genetic, physical exercise, environment, diet, and smoking.^{20,21} Lung function which was measured by FEV₁ also had several influencing factors. The type factor is the height and weight anatomy of the body, the location for pulmonary function calculation, respiratory muscle strength, lung and chest muscle growth as well.²² Age, gender, physical activity, pregnancy, and pathological status are some variables that could influence the VC.^{23,24} Spirometry results are also dependent on subjects' effort and consistency. Respiratory muscle strength and the range of physical activity of the respondent must also be taken into account.

Regarding gender difference in PFT & VO₂ Max

Statistically, there is a significant difference observed in FVC, FEV₁, FEF₂₅₋₇₅, PEFR, SVC & Statistically there is no significant difference observed in ERV, lung age, BMI, VO₂ Max between Male and female first-year MBBS students ($p > 0.05$, Table 2). Females have lower values for lung function parameters as their respiratory muscle endurance, and chest wall compliance is lower than males.¹¹ In addition to the anatomical and physiological variations, the gender disparity in lung function can also be responsible for many other causes, such as sex hormones, sex hormone receptors, or intracellular signaling pathways.^{12,13} This can be attributed to the fact that men have bigger lungs for the same height as compared to females. Another contributing factor could be the greater strength of respiratory muscles in males.¹⁴ Similar results with our study shown by Simon Green²⁵, Santu Dhara²⁶ they observed that VO₂ Max is more in males than females.

Similar results with our study shown by Nida nowreen²⁷, Shengyu Wang²⁸ Tim J.T. Sutherland²⁹, Joyashree Banerjee³⁰. They observed that FVC, FEV₁, PEFR is significantly less in female than male participants.

Conclusion

Medical students have unhealthy, stressful lifestyles. MBBS students in the 1st year perform less physical exercise, which causes their cardiopulmonary function to be impaired. It may lead to chronic & serious conditions if neglected for many years. Through a simple awareness program, we can show the results of their PFT & VO₂ max tests, and make them realize the status of their cardiopulmonary function. With the collaboration of a sport physiologist, doctors from the medicine department, and dieticians, we can advise the importance of physical exercise, a healthy lifestyle, & dietary modifications. Now-a-days in the first-year MBBS, competency-based curriculum, some hours are allotted for sports which will defiantly useful for their physical activity. It will directly improve cardiopulmonary status. However, much more initiatives should be taken at school, college, village, district, state, national level. So, the purpose of 'Prevention Is Better than Cure' will be served.

Limitation of this study was less sample sizes and we were unable to include different age groups. Suggestions for further studies are number of sample sizes should be increased and comparing of results should be done. Research should be done on the different age groups. The study could be continued to derive normative data of PFT & VO₂ Max over different ages.

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