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Differential Lung Capacity Patterns: Athletes, NCC Cadets, and Non-active College Students in Focus

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Abstract: Lung capacity, also known as pulmonary function, refers to the amount of air the lungs can hold and the ability of the respiratory system to move air in and out of the lungs. Adequate lung capacity contributes to an overall better quality of life. It allows individuals to engage in daily activities without experiencing breathlessness or fatigue, promoting independence and well-being. Maintaining and improving lung capacity is achievable through regular exercise, healthy lifestyle choices, and avoiding exposure to harmful environmental factors. There are several studies conducted to see the positive association between lung capacity and physical activity. Yet, the effect of the specific nature of activity on the lung capacity of the college-going population has not been revealed properly.This study delved into the critical aspect of lung capacity, essential for daily functioning and overall well-being. Focused on the female college student population, the research aimed to uncover the levels of lung efficiency across different physical activities. The sample of 45 students, aged 18 to 25, was divided into three groups: team sports (N = 15), NCC (National Cadet Corps) participants (N = 15), and non-active students (N = 15). Data collection involved utilizing Spirometry to measure key pulmonary function indicators, including Forced Vital Capacity (FVC), Forced Expiratory Volume in One Second (FEV1), and the FEV1/FVC ratio. Employing One Way ANOVA for statistical comparison of means, the study revealed a significant difference in the variable FEV1/FVC ratio among athletes, NCC participants, and non-active students. However, no significant distinctions were observed between students in NCC and sports, or between NCC participants and sedentary individuals. Crucially, the Pulmonary Function Test (PFT) scores of the physically active groups surpassed the standard Spirometry test score, emphasizing the positive impact of physical activity on lung health. The results underscore the essential role of engaging in sports and physical exercises for enhancing lung capacity. The study advocates for future research to delve deeper into strategies for optimizing lung health through sports and exercise, aiming to better understand and harness the potential benefits for individuals, particularly within a college-going population.

Keywords: Pulmonary Function Test, NCC Cadets, Spirometer, Athletes, Lung capacity

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Introduction

Lung capacity, or pulmonary function, refers to the volume of air that the lungs can hold and the efficiency of the respiratory system in moving air in and out. Adequate lung capacity is crucial for overall well-being. Assessing pulmonary function through lung function tests is essential for both qualitative and quantitative evaluations, playing a pivotal role in determining an individual's physiological fitness. Spirometry stands out as a key physiological test that measures an individual's inhalation and exhalation volumes over time. As the primary tool for objectively assessing respiratory system function, it provides valuable insights into pulmonary performance. While age, height, and weight are typically reliable indicators of lung volume, athletes consistently demonstrate larger-than-predicted lung volumes compared to non-exercisers. This observation underscores the distinct impact of regular physical exercise on respiratory physiology. The parameters of lung function often exhibit a correlation with lifestyle factors, including the distinction between individuals who engage in regular exercise and those who do not. Athletes, as a result of their consistent exercise routines, generally experience an augmentation in pulmonary capacity in comparison to their non-exercising counterparts.

Participating in sports extends beyond showcasing well-defined bodies and remarkable athletic accomplishments; it serves as a potent method to boost lung function, the essential powerhouse driving every physical endeavour. Scientific research consistently indicates that athletes, in contrast to those who lead a sedentary lifestyle, exhibit greater-than-expected lung capacities and heightened respiratory effectiveness. This phenomenon is not coincidental; rather, it underscores the significant influence of consistent physical activity on the respiratory system. This deep breathing is beneficial for expelling moisture from the lungs, as highlighted by Bedard *et al*. (2020). Engaging in regular exercise habits has been demonstrated to significantly increase the vital capacity of the lungs by approximately 30–40%. This improvement is attributed to the impact of muscular activities associated with breathing, leading to enhanced function and endurance of the respiratory muscles, as reported by Schodel and Ratcliffe (2019).The relationship between exercise and lung function is inversely correlated; issues with lung function can impact exercise. Conversely, consistent physical activity or exercise can positively influence lung function. Individuals who exercise regularly typically experience improved fitness, greater aerobic capacity, and enhanced vital capacity, as emphasized by Dugral *et al*. (2019).

This study delved into the critical aspect of lung capacity, essential for daily functioning and overall well-being. Focused on the female college student population, the research aimed to uncover the levels of lung efficiency across different physical activities.

Materials and Methods

45 Female college students (17-25 years of age) comprising athletes (N=15), NCC cadets (N=15), and physically non-active girls (N=15) were assessed for pulmonary function tests. The exclusion criterion was any kind of pulmonary disease.

Design and study setting:

The parameters used as determinants of lung function were Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1) and FEV1/FVC ratio and were recorded as per standard procedure using a digital spirometer (RMS Helios 702 Portable Spirometer -PFT). Informed consent was obtained and the procedure was explained to each subject during the test. The tests were carried out by a well-trained technician. The study subjects undergoing the tests were well informed about the instrument and the technique of the test by demonstration of the procedure. Participants were not provided with any incentives except for refreshments, and their involvement was entirely voluntary.

Table 1: Descriptive statistics: Pulmonary Function Test (PFT)

PFT variables	*Athletes*		*NCC Cadets*		*Physically Non Active students*	
	MEAN	SD	MEAN	SD	MEAN	SD
FVC	4.5233	.47561	4.3960	0.45566	4.0793	0.51727
FEV1	3.7633	0.49791	3.3847	0.46258	2.9833	0.62422
FEV1/FVC	82.9333	4.07898	76.8667	4.61158	72.6000	7.2975

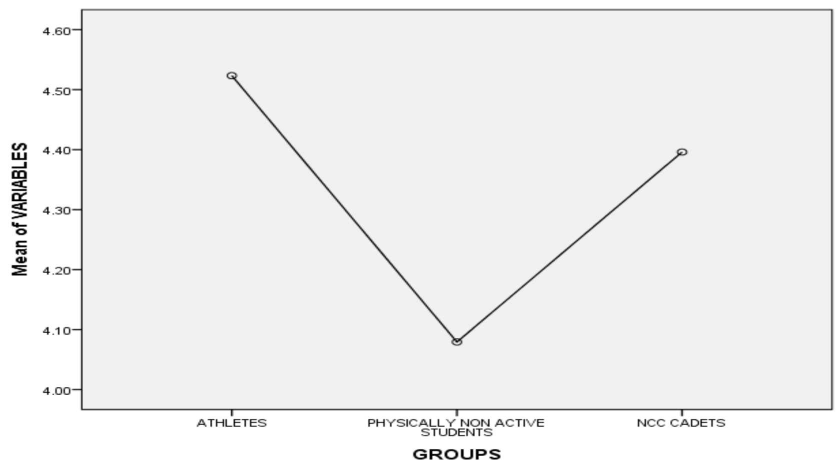

Fig. 1: Comparison of means of PFT variables.

Before testing, information on the subject age, date of birth, and the number of years of training (for land-based athletes and swimmers) was obtained verbally from the parent or coach. Subjects underwent the test in a sitting position, wearing a nose clip. After a maximal inhalation, they sealed their lips around the mouthpiece and exhaled as hard and as fast as possible. They were encouraged to continue exhaling for at least six seconds so that forced expiratory volume for one second (FEV1) and FVC could be measured. Direct measurements included FVC (litres), and FEV1 (litres) and the forced expiratory ratio (FEV1/FVC × 100) was also calculated (%).

(1) *Forced Vital Capacity* (*FVC*): It is a measure of the maximum amount of air a person can exhale forcefully and completely after taking a deep breath. It is a crucial parameter in pulmonary function tests and is used to assess the overall health and functioning of the lungs. FVC is expressed in litres and is an essential component in evaluating lung function and respiratory efficiency.

(2) *Forced Expiratory Volume in one second* (*FEV1*): It is a measure of the amount of air a person can forcefully exhale in the first second of a forced breath. It is a vital parameter in pulmonary function testing and provides valuable information about lung function.

(3) *The ratio of Forced Expiratory Volume in one second* (*FEV1*) *to Forced Vital Capacity* (*FVC*): It is a significant parameter used in pulmonary function testing to assess lung function and detect potential respiratory issues. This ratio, expressed as a percentage, is calculated by dividing the FEV1 by the FVC. In a healthy individual, the expected FEV1/FVC ratio is usually around 70-80%.

Statistical analysis:

Pulmonary test results were presented by

Table 2: ANOVA: comparison of means of PFT variables among different groups

		F	SIG.
FVC	Between Groups - Within Groups	3.354	0.045
FEV1	Between Groups - Within Groups	8.040	0.001
FEV1/FVC	Between Groups - Within Groups	13.310	0.0001

Table 3: Pair-wise Comparison (FVC)

GROUPS		TEST STATISTICS	SIGNIFICANCE (0.05)
Athletes	Physically non-active students	0.44400*	0.041
	NCC cadets	0.12733	0.752
Physically non-active students	Athletes	-0.44400*	0.041
	NCC cadets	-0.31667	0.184
NCC cadets	Athletes	-0.12733	0.752
	Physically non-active students	0.31667	0.184

descriptive methods of statistics, as measured values (litres) and as values calculated to the predicted values (percentages). One-way ANOVA test was used to evaluate differences among groups; Tukey –HSD Post Hoc test was used for the inter-group differences. The data were analysed using the Statistical Package for Social Sciences (SPSS) Version 23, based in Chicago, IL, and statistical significance was set at $P < 0.05$.

Results

Table 1 shows the mean and SD scores of the selected PFT factors (FVC, FEV1 and FEV1/FVC ratio of three different groups. As expected, athletes' scores in all three PFT factors were high compared to other groups (FVC-4.5233± 0.47561, FEV1- 3.7633±0.49791 and FEV1/FVC ratio-82.9333±4.07898). NCC cadets showed better scores (FVC- 4.3960 ±0.45566, FEV1-3.3847±0.46258 and FEV1/FVC ratio-76.86674±0.61158) compared to the sedentary students (FVC- 4.0793 ±0.51727, FEV1-2.9833±0.62422 and FEV1/FVC ratio-72.6000±7.2975).

Table 2 shows the results of the one way ANOVA conducted and significant differences found among all three groups in all three PFT factors (FVC-0.045, FEV1-0.001, and FEV1/FVC ratio-0.0001).

Since ANOVA results showed significant differences among different groups Pairwise comparison was done using Tukey-HSD post hoc test and the results are given in Tables 3, 4 and 5.

Table 3 shows the pairwise comparison results of the variable FVC and there is a significant difference between athletes and physically non-active group ($F=.041<0.05$) But no such difference between the other groups.

Table 4 shows the pairwise comparison results of the variable FEV1 and there is significant difference that exists only between athletes and the physically non-active group ($P<0.05$). But no

Table 4: Pair-wise Comparison (FEV1)

GROUPS		TEST STATISTICS	SIGNIFICANCE (0.05)
Athletes	Physically non-active students	0.78000*	0.001
	NCC cadets	0.37867	0.110
Physically non-active students	Athletes	-0.78000*	0.138
	NCC cadets	-0.40133	0.110
NCC cadets	Athletes	-0.37867	0.001
	Physically non-active students	0.40133	0.110

Table 5: Pair-wise Comparison (FEV1/FVC)

GROUPS		TEST STATISTICS	SIGNIFICANCE (0.05)
Athletes	Physically non-active students	10.33333*	0.0001
	NCC cadets	6.06667*	0.012
Physically non-active students	Athletes	-10.33333*	0.0001
	NCC cadets	-4.26667	0.098
NCC cadets	Athletes	-6.06667*	0.012
	Physically non-active students	4.26667	0.098

such difference between the other groups.

Table 5 shows the pair-wise comparison results of the variable FEV1/FVC ratio and there is a significant difference exists between athlete's vs physically non-active group ($P < 0.05$) and athletes vs NCC cadets ($P < 0.05$).

Discussion

The findings clearly indicate a positive correlation between the level of physical activity and lung capacity. Athletes engaged in regular sports training exhibit superior lung capacity compared to NCC cadets, whose physical activity is moderately lower, and notably higher than non-active students. Additionally, the NCC group, which undergoes a certain level of physical training, demonstrates better lung efficiency compared to the non-active group The present research results are consistent with earlier studies conducted by Jusuf Kurnia (2020). Kurnia's research suggested that engaging in aerobic exercise enhances the strength of external intercostal muscles in the ribs. As these muscles strengthen, they become more effective in expanding the chest cavity, facilitating increased airflow into the lungs. The present study is in conformity with the findings of Yuniana (2020) who have examined variations in lung vital capacity before and after swimming. The results of the current study can be elucidated by considering the enhanced functions of respiratory muscle strength, improved thoracic mobility, and the equilibrium achieved between lung and chest elasticity due to the consistent exercise undertaken by athletes. Therefore, regular physical activity appears to induce a variety of favourable physiological, psychological, and physical changes in individuals.

The current study is subject to certain limitations. Firstly, the sample size was restricted, and a larger population might have yielded more comprehensive and impactful results. Secondly, the study focused exclusively on female students, and as such, the findings cannot be generalized to the general population.

Conclusion

The study demonstrated that sedentary individuals exhibited inferior performance in Pulmonary Function Tests (PFT) compared to athletes and NCC cadets. Consistent exercise was associated with a positive impact on lung function, leading to increased pulmonary capacities. The findings of the present research underscore the significant role of regular exercise training in influencing and enhancing lung volumes. Furthermore, the study highlights the potential utility of pulmonary function tests as a screening tool to identify individuals at risk of respiratory disorders. The insights gained from assessing respiratory functions through Spirometry can contribute to improving population health by encouraging lifestyle modifications. Further research can be done to understandhow different types of exercise impact lung capacity over extended periods and can provide valuable insights for designing personalized exercise programs.

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