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Original Article

A Comparative Study of Pulmonary Function Tests between Normal Male Sedentary and Tennis Players

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Abstract

Background: In the assessment of the respiratory system, pulmonary function tests (PFTs) have achieved a lot of importance nowadays due to an increase in the cardiorespiratory disease and to a steep rise in air pollution. These functional tests and their parameters tend to have a relationship with lifestyle such as regular exercise and non-exercise. Hence, the present study was undertaken to assess the effects of exercise in tennis players on the respiratory system which are compared with normal healthy sedentary individuals.

Aim of the Study: The aim of this study was to determine and compare the differences between the pulmonary functions of healthy individuals playing regular tennis for 2 h daily and normal sedentary individuals.

The Objective of the Study: The study included 39 tennis players playing regular tennis for 2 h and 37 normal sedentary individuals who are not interested in any sports or games actively.

Materials and Methods: PFTs such as forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), peak expiratory flow (PEF), VC, and maximum voluntary ventilation (MVV) of the study group were included in the study. The results were analyzed with standard spirometer. The arithmetic means and standard deviations of data have been obtained in the statistical evaluation. As a result of the findings obtained, independent sample *t*-test has been applied.

Observations and Results: No significant difference has been found among the age, height, body weight, body mass index, FEV1, and PEF values of the groups at the end of the test ($P > 0.05$); however, a significant difference has been found among MVV, FVC, and VC values.

Conclusions: Final analysis of the study showed that no difference is present between the FEV1 and PEF values of tennis players who have long-term and regular exercises and sedentary individuals. However, there is a significant difference among MVV, FVC, and VC values between the two groups. Therefore, it has been found that the pulmonary capacities (MVV, FVC, and VC) of individuals having regular exercises have higher values than that of sedentary individuals.

Key words: Athletes, Exercise, Maximum voluntary ventilation and vital capacity, Pulmonary function tests

INTRODUCTION

During exercise, it is evident that both respiratory and circulatory systems work in close interaction.[1] For healthy growth and maintenance of the body, regular and systematic physical exercises is important.[2] The increased demand of oxygen by the working muscles has to be met by the respiratory system which should adapt to the said status to satisfy the required oxygen. However, this increased level is limited, and the limits of the enlargement capacity of breathing muscles and chest wall and elasticity levels of bronchi lead to changes in that particular status.[3] The amount of oxygen used by the muscles is directly proportional to the amount of energy they generate.[4] The oxygen and carbon dioxide values are maintained at an appropriate level without increasing the load on the

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breathing muscles during the exercise.[5] Heart rate increases to meet increasing oxygen demand,[6] the energy used by the breathing muscles is decreased, and the signals that will increase the pulmonary functions tend to be minimized. Due to these chain events, the exhaustion that is bound to occur otherwise in the breathing muscles is decreased; however, exercise performance is increased.[5] During the exercises, there would be increase in the consumption rate of O_2 in the metabolism, which is also called $MaxVO_2$, is experienced. It is indicated that said increase is above 10%. Therefore, it is important to increase the availability of oxygen, in other words, $MaxVO_2$, during the exercises.[7] It is accepted that the exercise is effective extremely on the circulatory and respiratory systems. The pulmonary capacity and functions of an individual are related to his body structure as well as the oxygen need of the sport or exercise performed by him. The respiratory systems of the athletes who are trained adequately adapt to the increasing oxygen need during the exercise rapidly.[8] Elite endurance athletes have parallel increases of left atrial pressure and right atrial pressure (Pra) at high levels of exercise, whereas less well-trained or sedentary subjects have smaller increases in Pra than pulmonary wedge pressure with exercise, which suggests that pericardial constraint is acting in the elite athletes at very high levels of exercise. Further confirmation of this theory is provided by studies with athletic animals, in which removal of the pericardium resulted in increased peak end-diastolic volume, stroke volume, and maximal oxygen uptake.[6] The pulmonary volumes and capacities of the people differ (age, sex, body surface, exercise condition, athlete, and sedentary individuals). Therefore, it is better to evaluate the pulmonary functions of the athletes in accordance with maximum voluntary ventilation (MVV) results. Apart from MVV, the rate of FEV/forced vital capacity (FVC), which is below 80%, is accepted as a problem.[9] The effects of physical activity on the pulmonary functions are tried to be classified as early age, adolescence, and adulthood stage. While making the classifications, the effects of the exercises performed in accordance with the branches, on the pulmonary functions, must be taken into consideration. Certain lifestyle parameters such as smoking, lack of habitual physical activity, low physical fitness, high dietary intake, and consumption of alcohol can alter the lung function.[10] Smoking tends to have a deleterious effect on lung function. Alternately, having a physical fitness and good physical activity is said to have positive effect on lung function.[11] The parameters of lung functions are considered as important indicators of health in clinical research.[12] Pulmonary function test (PFT) is considered as one of the important tools for the assessment of respiratory function.[13] PFTs determine the objective and quantifiable measures of the lung function. They are used to evaluate and diagnose diseases that affect lung function and heart function, to determine the effects of environmental, occupational, and drug exposures.[14] PFT aids in information about the small and large airways, the lung parenchyma, and the integrity, and size of the pulmonary capillaries.[14] The objective of this study is to determine the differences between the pulmonary functions of the individuals who are regular long-term players of tennis and sedentary individuals in accordance with new literature data.

Type of the Study

This was a prospective, cross-sectional, and comparative study.

Duration of the Study

The study duration was from December 2017 to July 2018.

Institute of the Study

The study was conducted at the Government Medical College and Hospital, Anantapur, Andhra Pradesh.

MATERIALS AND METHODS

A total of 40 subjects were included in these studies who were divided into two groups. Group A consisted of 20 tennis players and Group B consisted of normal healthy individuals. A long-term healthy tennis player was defined as one who is playing tennis for >10 years regularly and has not suffered from any acute cardiovascular or respiratory illnesses during this period, with at least 2 h of active power tennis game daily (minimum 14 h/week). Healthy sedentary controls were adult males who have not suffered from any acute cardiovascular or respiratory illnesses during 10 years' period and conditioned to not being connected with any particular sport activity and with no regular exercise program. Data concerning age and social habits such as smoking, alcohol, dietary intake, and type of work were observed and tabulated.

Inclusion Criteria

1. Adult males who are regular tennis players for >10 years were included.
2. Adult healthy sedentary males were included.
3. Males aged between 35 and 65 years were included.
4. Males who consented to participate in the study were included in the study.

Exclusion Criteria

1. Males who were suffering from any kind of pulmonary disease were excluded.
2. Males who have suffered from recent acute attacks of cardiorespiratory illnesses were excluded.
3. Males who have undergone any type of surgical procedures on the chest or abdomen were excluded from the study.

Table 1: The mean values of demographic data of the subjects (*n*=40)

Groups	Age	Height	Weight	BMI	Smoking (%)	Alcohol (%)	Working (%)
A - Tennis players - 20	48.5±3.75	5.7±0.4	73.50	28.40	10	67	82
B - Control group - 20	49.10±2.60	5.8±0.6	71.25	29.15	12	78	85

BMI: Body mass index

Table 2: The PFT parameters in the subjects (*n*=40)

Pulmonary function parameters	Groups	Mean and standard deviation	*P* value
FEC (L)	Group A	5.43±0.37	0.041
	Group B	5.10±0.76	
FEV1 (L)	Group A	4.35±0.28	0.376
	Group B	4.12±0.41	
PEF (L/s)	Group A	8.55±1.46	0.710
	Group B	8.51±2.10	
MVV (L/min)	Group A	116.54±38.24	0.023
	Group B	152.37±45.18	
VC (L)	Group A	5.79±1.11	0.034
	Group B	4.65±0.97	

FEC: Forced Expiratory Capacity, FEV1: Forced expiratory volume in 1 s, PEF: Peak expiratory flow, MVV: Maximum voluntary ventilation, VC: Vital capacity, PFT: Pulmonary function test

All tests were performed in laboratory settings with the same instruments and techniques.

Measurement

Standard spirometry was performed using the same instrument for all the subjects. 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 fast as possible. They were encouraged to continue exhaling for at least 6 s so that forced expiratory volume for 1 s (FEV1) and FVC could be measured. Tests were repeated 3–5 times until the two highest were recorded; FVC and FEV1 varied by <3%. Direct measurements included FVC (L), FEV1 (L), and PEF (L/s). The forced expiratory ratio (FEV1/FVC ×100) was also calculated (%). All of the above measurements were carried out under standard environmental conditions, by continuously measuring the temperature, humidity, and atmospheric pressure which enabled comfort temperature (between 18°C and 22°C), the atmospheric pressure of 760 mmHg, and a relative atmospheric humidity of 30–60%. Body mass (kg) and body height (m) were measured using standardized anthropometric techniques. Body mass index was calculated for all participants as the ratio of body mass (kg) divided by the body height (m) squared. An ethical approval was obtained from the institutional ethical committee. All the data were analyzed using standard statistical methods [Table 1].

OBSERVTOINS AND RESULTS

When the findings of the study have been evaluated, no significant difference was found between FEV1 and PEF values ($P > 0.05$); however, a significant difference was found among MVV, FVC, and VC values ($P < 0.05$ which was taken as statistically significant) [Table 2].

DISCUSSION

The principle function of the respiratory system is to maintain the blood gas levels within fixed limits and to provide gas exchange between blood and air.[9] In the present study, no significant difference has been found between FEV1 and PEF values ($P > 0.05$); however, a significant difference was found among MVV, FVC, and VC values ($P < 0.05$). The study results showed that the FVC, FEV1, and MVV ratios were higher in tennis players than in the normal sedentary control individuals, similar to the studies conducted by other authors.[15-18] FVC and MVV findings of these authors support the present study and could be considered as an important correlation. Similar observations were made by Prakash *et al*.[16] with reference to FVC. A study by Stuart and Collings[19] also reported higher mean FVC scores in athletes as compared to non-athletes. In relation to the FEV1 values in this study, there was no statistical significant difference, but few authors showed, When Sedentary and Athlete groups were compared; they showed higher FEV1 in Athletes when compared to sedentary individuals,[16,20] while Khanam *et al*.[21] did not observe any significant change in FEV1 similar to the present study. Due to an increase in pulse volume, a less cardiac pulse is required. The increase in pulse volume helps O_2, which is required during maximal exercises, to be transferred to the muscles. In the meantime, the increase in pulmonary volume and capacity increases the passing movement of O_2 from the lungs to the blood.[22] Such an increase may arise from the positive effect of exercise on dynamic pulmonary capacity together with strengthening in the breathing muscles. It is indicated that exercises cause increase in pulmonary functions,[23] while aerobic exercises lead to a higher level of increase in FVC values when compared to anaerobic exercises.[24]

CONCLUSIONS

Final analysis of the study showed that no difference is present between the FEV1 and PEF values of tennis players who have long-term and regular exercises and sedentary individuals. However, there is a significant difference among MVV, FVC, and VC value between the two groups. Therefore, it has been found that the pulmonary capacities (MVV, FVC, and VC) of individuals having regular exercises have higher values than that of sedentary individuals.

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