

## Original Research

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### KEYWORDS:

acute exercise; ventilatory function; pulmonary function tests; oxygen saturation; spirometry; pulse oximetry.

## Acute Effect of Exercise on Ventilatory Function and Oxygen Saturation for Students and Employers at Kafr Elsheikh University

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**ABSTRACT: Background:** Acute exercise produces immediate cardiopulmonary responses that may alter ventilatory function and oxygen saturation.

**Objective:** To assess the acute effects of exercise on pulmonary function and oxygen saturation in healthy students and employees.

**Methods:** Fifty healthy men aged 18–25 years were recruited from Kafr elsheikh University. Pulmonary function parameters and peripheral oxygen saturation were measured by spirometry and pulse oximetry before and after a graded treadmill exercise protocol. Pre- and post-exercise values were compared using a paired t test, with statistical significance set at  $p \leq 0.05$ .

**Results:** Exercise significantly increased FEV1 from  $3.58 \pm 0.33$  to  $3.74 \pm 0.37$  L ( $p = 0.001$ ) and FVC from  $4.10 \pm 0.40$  to  $4.30 \pm 0.40$  L ( $p = 0.003$ ). PEF also changed significantly ( $p = 0.013$ ), while heart rate increased from  $77.63 \pm 9.83$  to  $106.19 \pm 11.61$  beats/min ( $p = 0.001$ ). No significant differences were observed in the FEV1/FVC ratio ( $p = 0.390$ ) or oxygen saturation, which changed from  $95.93 \pm 2.06\%$  to  $96.37 \pm 1.88\%$  ( $p = 0.381$ ).

**Conclusion:** Acute treadmill exercise produces significant short-term changes in selected ventilatory and cardiovascular parameters, but does not significantly alter oxygen saturation in healthy young adults.

## INTRODUCTION

The human body needs oxygen to sustain itself. A decrease in oxygen is known as hypoxia and a complete lack of oxygen is known as anoxia. (1)

These conditions can be fatal; after about four minutes without oxygen, brain cells begin dying, which can lead to brain damage and ultimately death. (1)

The respiratory response to exercise depends on the level of exercise performed which can be conveniently divided into: moderate exercise, heavy exercise or severe exercise. (2)

The most commonly used measure of respiratory function with exercise is known as  $\text{VO}_2$  (volume of oxygen uptake).  $\text{VO}_2$  refers to the amount of oxygen taken up and used by the body. The relationship between exercise and ventilator function is that ventilation increases to meet the demands of exercise through the following two methods: increase in 'tidal volume' which refers to the quantity of air that is inhaled and exhaled with every breath. This is similar to 'stroke volume' in the cardiovascular system. (3)

An increase in the 'respiration or breathing rate' which refers to how many times a person completes an inhalation and exhalation every minute. This is similar to 'heart rate' in the cardiovascular system. If the exercise is intense, breathing rates may increase from a typical resting rate of 15 breaths per minute up to 40 – 50 breaths per minute. (3)

Whenever an individual engages in exercise, the body responds physiologically to meet the increased energy demands of the activity. These immediate short-term responses that last only for the duration of the activity are referred to as acute responses. (4)

The acute responses include increasing ventilation, tidal volume, breathing rate, oxygen uptake  $\text{VO}_2$ , pulmonary diffusion, arteriovenous oxygen difference ( $a\text{-VO}_2 \text{ diff}$ ), heart rate, stroke volume, cardiac output and Excess post-exercise oxygen consumption (EPOC) and Redistribution of blood flow to working muscle. (4)

### Significance of the study:

Healthy living and physical fitness are closely related. Physical activity is known to improve physical fitness and to reduce morbidity and mortality from numerous chronic diseases. This study was done to evaluate the effects of acute exercise on ventilatory function and oxygen saturation in healthy adult volunteers. Exercise is the body's most common physiologic stress, and it places major demands on the cardiopulmonary system.

### Aim of the study:

The goal of this was to assess the effect of acute response of exercise on ventilatory function and oxygen saturation in students and employees in the main campus of Kafr elsheikh University.

## REVIEW OF LITERATURE

### Ventilatory function:

The respiratory system conducts inhaled air through progressively branching airways to the respiratory zone. The trachea divides into the main bronchi, which continue as lobar and segmental bronchi and then terminal bronchioles. The conducting airways do not participate in gas exchange and form the anatomical dead space, whose volume is approximately 150 ml. (5, 6)

The nose and ciliated epithelium provide an important protective barrier by trapping and removing airborne particles; smoking can impair ciliary activity. Gas exchange occurs in the respiratory zone, which includes respiratory bronchioles and alveolar ducts and accounts for most of the lung volume. (6–8)

## **Mechanics of breathing:**

Inspiration is an active process initiated by the medullary respiratory center. Contraction of the diaphragm and external intercostal muscles expands the thoracic cavity, lowers pleural pressure and draws air into the alveoli. The diaphragm is the principal inspiratory muscle, while the intercostal muscles further increase thoracic volume. (9–11)

Expiration is normally passive because of elastic recoil. During exercise or airway narrowing, the internal intercostal and abdominal muscles contract to increase pleural pressure and accelerate expiration. (9)

## **COUPLING OF THE LUNGS AND THE CHEST WALL:**

The lungs are coupled to the chest wall through the visceral and parietal pleura and the thin fluid layer between them. Consequently, changes in thoracic volume and shape are transmitted to the lungs. (12)

## **PRESSURE-VOLUME RELATIONSHIP:**

Respiratory pressures are expressed relative to atmospheric pressure, which is approximately 760 mm Hg at sea level. An alveolar pressure of zero therefore indicates equality with atmospheric pressure. During inflation and deflation, the pressure–volume curves differ (hysteresis), and some air remains trapped in the alveoli, with the trapped volume increasing with age and respiratory disease. (13)

## **COMPLIANCE:**

Compliance is the change in lung volume per unit pressure. Normal lung compliance is approximately 0.15 L/cm H<sub>2</sub>O and decreases as the lung is expanded beyond its normal range. It is reduced by pulmonary venous congestion, oedema, atelectasis and fibrosis, whereas emphysema increases compliance. Compliance also varies with lung size and age; specific compliance corrects for lung volume. (14–16)

In humans, compliance is commonly assessed from the pressure–volume relationship during passive expiration from total lung capacity, using oesophageal pressure as an estimate of pleural pressure. (14)

## **SURFACE TENSION:**

A liquid film lines the alveoli and creates surface tension that tends to reduce alveolar surface area and contributes to lung recoil. Lungs filled with saline have greater compliance than air-filled lungs because saline abolishes surface tension. (17–19)

Surfactant, produced by type II alveolar epithelial cells and containing dipalmitoyl phosphatidylcholine, lowers surface tension, increases compliance, reduces the work of breathing, stabilizes alveoli and helps keep them dry. Inadequate surfactant in premature infants can cause respiratory distress. (17, 19)

## **REGULATION AND CONTROL OF BREATHING:**

Breathing is regulated to maintain appropriate oxygen and carbon dioxide levels. The control system includes the brainstem respiratory centers, the medullary and pontine centers, respiratory muscles and sensory receptors. (20)

### **Central controller**

Automatic, rhythmic breathing is generated mainly in the pons and medulla, where respiratory neurons coordinate the activity of the respiratory muscles. (20)

### **Medullary respiratory center:**

Dorsal medullary neurons are primarily associated with inspiration and establish the basic respiratory rhythm. Ventral medullary neurons are usually inactive during quiet breathing but become active during forced expiration and heavy breathing. (21, 22)

### **Apneustic Centre:**

The Apneustic center in the lower pons stimulates the inspiratory center; reduced influence from this center produces shallow and irregular breathing. (22)

### **Pneumotaxic center:**

The Pneumotaxic center in the upper pons inhibits the inspiratory and Apneustic centers, helping to terminate inspiration and regulate respiratory volume and rate. (23, 24)

## **RESPIRATORY MUSCLES:**

The diaphragm, intercostal muscles and accessory respiratory muscles coordinate their activity under central control to produce normal breathing. (25)

## **SENSORS:**

### **MECHANORECEPTORS:**

Mechanoreceptors in the bronchi and bronchioles respond to lung inflation and help prevent over inflation by inhibiting inspiratory neurons through the vagus nerve. (25)

### **CHEMORECEPTORS:**

Chemoreceptors monitor oxygen, carbon dioxide and pH. Peripheral receptors are located in the carotid and aortic bodies, while central receptors lie in the medulla and respond mainly to changes in hydrogen-ion concentration related to carbon dioxide. Increased carbon dioxide and hydrogen-ion concentration stimulate hyperventilation; even a small rise in arterial  $PCO_2$  can markedly increase the rate and depth of breathing. (26–29)

## **Physiological responses to exercises:**

Regular physical activity benefits quality of life and supports cardiovascular and pulmonary health. During exercise, the lungs increase oxygen uptake and carbon dioxide removal while the heart transports oxygenated blood to the working muscles. (30, 31)

Exercise intensity may be classified as moderate, heavy or severe according to the anaerobic threshold and the behavior of arterial lactate. As intensity rises, oxygen consumption, ventilation and circulation increase to meet metabolic demand. (32)

## **Breathing pattern during exercise:**

Minute ventilation increases during exercise through increases in tidal volume and breathing frequency. At low and moderate intensities both rise with workload; at higher intensities tidal volume reaches a plateau and further increases in ventilation depend mainly on breathing frequency. The ratio of dead space to tidal volume decreases, improving alveolar ventilation. (32, 33)

At increasing intensity, end-inspiratory volume rises and end-expiratory volume generally falls, improving diaphragm length-tension conditions and reducing inspiratory muscle work. At very high lung volumes, compliance falls and the work required for a given volume change increases. (34–36)

## **Control of airway caliber during exercises:**

The upper airway contributes most of the airflow resistance at rest and during exercise. As ventilation increases, breathing shifts from predominantly nasal to oronasal, nasal resistance falls, and the upper-airway muscles are activated to reduce collapsibility and maintain airflow. Expiratory glottis narrowing is also reduced during exercise. (37–39)

## **Bronchial caliber:**

Exercise produces Broncho dilatation in healthy individuals and can prevent an increase in pulmonary resistance.  $FEV_1$  increases immediately after exercise in normal and asthmatic subjects. The response involves withdrawal of vagal tone, mechanical enlargement of the airways as operating lung volumes rise, and relaxation of bronchial smooth muscle. (40–44)

## **Work of breathing during exercise:**

The work of breathing is the product of respiratory muscle force and the change in muscle length. It includes elastic work, which overcomes lung and chest-wall recoil, and flow-resistive work, which overcomes airway resistance and gas viscosity. Broncho dilatation during exercise reduces the flow-resistive component. (45–48)

## **Work performed on the abdomen and rib cage:**

Respiratory muscles also perform work on the abdominal wall and rib cage. Abdominal-wall work can account for up to 25% of the total work of breathing during exercise, while coordinated respiratory muscle recruitment minimizes rib-cage distortion. (49–53)

## **Energy cost of the work of breathing during dynamic exercise:**

The work performed per liter of ventilation rises from rest to maximal exercise. In trained athletes, respiratory-muscle oxygen consumption may reach approximately 15% of total body oxygen consumption during maximal exercise; in untrained young adults, the proportion is about 10%. (54, 55)

## **Pulmonary hemodynamics and lung fluid homeostasis during exercise:**

During high-intensity exercise, cardiac output and pulmonary blood flow may increase to four or five times resting levels, allowing large increases in oxygen uptake and carbon dioxide elimination. Rising left-ventricular filling pressure recruits and distends pulmonary vessels, expanding the capillary surface area. (56, 57)

## **Pulmonary circulation during exercise:**

Exercise increases pulmonary arterial pressure and blood flow, while pulmonary vascular resistance generally falls. Increased venous return and ventricular filling support stroke volume through the Starling mechanism; neural, humoral and mechanical factors contribute to pulmonary vascular regulation. (58–61)

## **Lung fluid homeostasis during exercise:**

Although pulmonary blood flow and capillary pressures rise during exercise, pulmonary oedema is minimized because capillary absorptive pressure and lymphatic flow also increase. (62, 63)

## **Gas exchange during exercise**

Gas-exchange efficiency is commonly described by the alveolar–arterial oxygen difference ( $PA-aO_2$ ), which is normally 5–10 mm Hg at rest and may increase to 15–25 mm Hg or more during maximal exercise. The main contributors are ventilation–perfusion mismatch and venous admixture; diffusion limitation is generally unimportant in healthy untrained people but may contribute at very high workloads in highly trained athletes. (64–80)

## **Exercise-induced respiratory muscle fatigue:**

Respiratory muscles are generally well suited to the ventilatory demands of exercise. Nevertheless, endurance exercise can reduce diaphragmatic pressure-generating capacity by approximately 15–50%, particularly when diaphragm work is high or when oxygen supply is limited. Respiratory muscle fatigue is most likely at workloads above 85% of  $VO_{2max}$  or when arterial oxygen content is reduced, although it usually does not compromise alveolar ventilation. (81–87)

## **Limitations to the response of the healthy lungs to exercise:**

The healthy young lung usually meets the increased demands of exercise without important impairment of blood-gas homeostasis or breathing mechanics. Exceptions include exercise-induced arterial hypoxemia at high altitude and, in some highly trained athletes, reduced arterial oxygen saturation associated with a widened  $PA-aO_2$  and limited hyperventilation. Ageing can further reduce diffusion capacity, elastic recoil and maximal flow, increasing the likelihood that the lung will limit exercise performance. (88–93)

## **Benefits of exercise:**

Regular exercise strengthens the muscles, improves circulation and cardiac function, and reduces the oxygen required for a given workload. It also supports physical and psychological well-being and lowers the risk of stroke, heart disease and type II diabetes. (94)

## **Respiratory Responses to Exercise:**

The respiratory system supplies oxygen to tissues and removes carbon dioxide. Pulmonary ventilation increases in proportion to exercise intensity and metabolic demand through higher tidal volume and breathing frequency. Oxygen uptake rises with continuous exercise until a maximum is reached. (95)

After exercise, ventilation remains elevated to repay the oxygen deficit, remove carbon dioxide and restore acid–base balance. The duration of this response increases with exercise intensity. Short, high-intensity work with long recovery periods produces a relatively small respiratory response, whereas endurance and anaerobic training produce larger and more prolonged responses before breathing returns to baseline. (96–98)

## **Pulmonary function tests (PFTs)**

Pulmonary function tests are non-invasive measures of lung volumes, capacities, flow rates and gas exchange. Obstructive disorders primarily impair expiratory flow, whereas restrictive disorders limit lung expansion. Spirometry and plethysmography are commonly used methods. (99)

### **PFT measures:**

PFT measures include tidal volume, minute volume, vital capacity, functional residual capacity, residual volume, total lung capacity, forced vital capacity, forced expiratory volume, forced expiratory flow and peak expiratory flow rate. Results are compared with expected values for people of similar age, height, sex and race. (100, 101)

### **Oxygen saturation:**

Oxygen saturation is the proportion of hemoglobin bound to oxygen; normal values are usually 96–98%. It depends on oxygen availability, pulmonary gas exchange, hemoglobin concentration and hemoglobin–oxygen affinity. (102)

## **Measuring Oxygen Saturation**

Oxygen saturation is commonly measured by arterial blood gases ( $\text{SaO}_2$ ) or pulse oximetry ( $\text{SpO}_2$ ). Pulse oximeters estimate the percentage of hemoglobin bound to oxygen by comparing the absorption of red and infrared light. (103)

## **Hypoxemia and Hypoxia**

Hypoxemia is reduced oxygen concentration in the blood, whereas hypoxia describes inadequate oxygen delivery or use by tissues. Hypoxia may also result from anaemia, inadequate blood flow, impaired tissue oxygen use or increased tissue demand. (104)

## **Treating Hypoxemia and Hypoxia Due to Hypoxemia**

When oxygen saturation falls, treatment should include supplemental oxygen when clinically indicated and investigation of the underlying cause. (104)

### **Effect of exercise on the body:**

During exercise, the cardiovascular, respiratory, energy and muscular systems work together to supply oxygen to active muscles and remove metabolic waste. Acute responses include increased heart rate, stroke volume, cardiac output, breathing rate, tidal volume, minute ventilation, oxygen uptake, carbon-dioxide removal, lactate production, muscle temperature and fatigue. (105)

When a person takes part in exercise the cardiovascular, respiratory, energy and muscular systems all work together to supply energy to the working muscles and remove waste products.

When the muscles start to work, they need more oxygen so that the respiratory system responds by getting more oxygen into the lungs. The blood carries greater amounts of oxygen and the heart responds to pump more oxygenated blood around the body. (105)

These effects are shown in table (1) (105)

|                                  | Short term effects of exercise                                                                                                                       |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cardiovascular system</b>     | Increase in stroke volume (SV); increase in heart rate (HR); increase in cardiac output (Q); increase in blood pressure redistribution of blood flow |
| <b>Respiratory system</b>        | Increase in breathing rate (BR); increase in tidal volume (TV); increase in minute ventilation (VE)                                                  |
| <b>Cardio-respiratory system</b> | Increase in oxygen uptake and transport to the working muscles; increase in carbon dioxide removal                                                   |
| <b>Energy system</b>             | Increase in lactic acid (lactate) production                                                                                                         |
| <b>Muscular system</b>           | Increase in temperature of muscles; increased pliability muscle fatigue                                                                              |

## Long term effects of exercise on the body systems:

Taking part in regular exercise or training around three times per week for six weeks will lead to adaptation of the body systems that are used or trained. This has the effect of increasing performance in that type of exercise or sport and is often beneficial to general health and everyday life. (105)

|                              | Long term effects of exercise                                                                                                                                                                                                                                           | Type of training   |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| <b>Cardiovascular system</b> | Cardiac hypertrophy; increased stroke volume (SV) at rest and during exercise; decrease in resting heart rate (HR); increase in cardiac output (Q); capillarisation at the lungs and muscles; increase in number of red blood cells                                     | Aerobic            |
| <b>Respiratory system</b>    | Increased vital capacity; increase in minute ventilation (VE); increase in tidal volume (TV); decrease in breathing rate (BR); increased number of functioning alveoli; increased strength of the respiratory muscles (internal and external intercostal and diaphragm) | Aerobic            |
| <b>Energy system</b>         | Increased production of energy from the aerobic energy system; increased tolerance to lactic acid                                                                                                                                                                       | Aerobic; anaerobic |
| <b>Muscular system</b>       | Muscle hypertrophy; increased strength of tendons; increased strength of ligaments                                                                                                                                                                                      | Resistance         |
| <b>Skeletal system</b>       | Increase in bone density                                                                                                                                                                                                                                                | Resistance         |

(105)

## SUBJECTS AND METHOD

### I-Subjects

Fifty men subjects participated in this study. They were recruited from the students and employs from the main campus, Kafr elsheikh University. their ages ranged from 18 to 25 years old. All of them were quite healthy.

## Inclusion Criteria:

1. All participants were either students or employees of the Kafr elsheikh University.
2. Their ages were between 18 to 25 years old.
3. All participants were within normal weight ( $18,5 - 24,9 \text{ kg/m}^2$ ) or overweight ( $25 - 29,9 \text{ kg/m}^2$ ).
4. All participants signed consent to participate in the study. Appendix (1)
5. All participants are in quite health.

## Exclusion criteria:

1. Smokers
2. Class III Obesity ( $35 - 39,9 \text{ kg/m}^2$ ) or more .
3. sever musculoskeletal and cardiopulmonary disorders
4. Any chronic diseases.

## II-Instruments:

- 1- Height and weight scale to assess the height and weight of the subject fig. (1).



- 2- Spirometry to assess the PFT, fig. (2)



- 3- Pulse oximetry to assess oxygen saturation



### III-Procedure:

#### 1- Assessment procedures

##### -Pulmonary function tests procedure:

Pulmonary function tests were conducted in Kafr elsheikh University.

- The subject instructed not to engage in heavy exercise immediately before testing.
- The subject height and weight were recorded.
- Getting the subject comfortable and in the proper position, the sitting position is preferred for safety reasons (avoid falling due to syncope), be sure the subject sits up straight and the subject's legs are uncrossed. The chair should have arms and be without wheels.
- The subject loosen any tight clothing, such as neckties, belts, or bras. Dentures should be left in place unless they are loose and interfere with performance of the test.
- Instructors explained the procedure to subject and offer the opportunity to ask any questions that you might have about the procedure.
- Generally, no prior preparation, such as fasting, fluid restriction, or sedation is required. However, subject may be asked to avoid eating a heavy meal before the test.
- Explaining and demonstrating the maneuver, the mouthpiece and a tight-fitting nose clip was attached to the subject's nose to prevent air leakage. Explain how the mouthpiece fits into the mouth, be sure to tell the subject not to bite down because this will obstruct the tubing hole.
- The subject's lips should be sealed tightly, and the tongue should not stick out into the mouthpiece, the chin should be slightly elevated and the neck slightly extended.
- Give specific instructions in simple terms that describe the rapid and maximal inspiration, a strong exhalation (blasting the air out), and continued exhalation until all the air is exhaled.
- Instructor may need to raise your voice with some urgency, using such phrases as "BLAST your air out," "blow, blow, blow," "keep blowing, keep blowing," or "don't stop blowing." However, some subjects perform better with softer coaching.
- With subject mouth forming a tight seal around the mouthpiece, instructor instructed to perform various breathing maneuvers. The maneuvers were done by inhaling and exhaling, depending on what measurements are ordered, instructor asked to repeat the maneuvers several times before the test is completed.

Oxygen saturation is the fraction of [oxygen]-saturated hemoglobin relative to total hemoglobin (unsaturated + saturated) in the blood. The human body requires and regulates a very precise and specific balance of oxygen in the blood. Normal blood oxygen levels in humans are considered 95–100 percent.

- PFT and Oxygen saturation were performed for each participant before and after the exercise

#### 2-Exercise procedure:

1. Assessment the pulmonary function pre and post the procedure.
2. Check the saturation with pulse oximetry pre and post the procedure.
3. Ask the volunteer to get on the treadmill and start by warming up at 3 mils/h for 2 minutes.
4. Then raise the speed to 4mil/h for 3 minutes.
5. After that raise the speed to 5mil/h for 2 minutes.
6. Finally give the volunteer period of cool down at 3mil/h for 3 minutes.

## RESULTS

### Statistical analysis

Results are expressed as mean  $\pm$  standard deviation. Comparison between variables measured at pre-treatment and post-treatment in the same group was performed using paired t test. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. P value  $\leq 0.05$  was considered significant.

## Descriptive Statistics

|                       | No. | Minimum | Maximum | Mean   | Std. Deviation |
|-----------------------|-----|---------|---------|--------|----------------|
| Age                   | 50  | 20.2    | 22.3    | 21.4   | 0.62           |
| Weight                | 50  | 50.00   | 89.00   | 72.11  | 9.84           |
| Height                | 50  | 154.00  | 180.00  | 169.22 | 7.03           |
| BMI                   | 50  | 19.00   | 29.00   | 24.74  | 2.78           |
| FEV1 pre              | 50  | 3.05    | 4.12    | 3.58   | 0.33           |
| FEV1 post             | 50  | 3.06    | 4.50    | 3.74   | 0.37           |
| FVC pre               | 50  | 3.13    | 4.87    | 4.10   | 0.40           |
| FVC post              | 50  | 3.27    | 5.00    | 4.30   | 0.40           |
| FEV1/FVC pre          | 50  | 73.00   | 95.00   | 85.26  | 5.27           |
| FEV1/FVC post         | 50  | 73.00   | 94.00   | 85.67  | 5.14           |
| PEF pre               | 50  | 5.09    | 11.53   | 7.84   | 1.90           |
| PEF post              | 50  | 4.93    | 12.71   | 8.53   | 1.91           |
| HR pre                | 50  | 56.00   | 95.00   | 77.63  | 9.83           |
| HR post               | 50  | 85.00   | 140.00  | 106.19 | 11.61          |
| SPO <sub>2</sub> pre  | 50  | 91.00   | 99.00   | 95.93  | 2.06           |
| SPO <sub>2</sub> post | 50  | 92.00   | 99.00   | 96.37  | 1.88           |

As regards FEV1, there was a statistical significant increase in the mean value of FEV1 measured at post-treatment ( $3.74 \pm 0.37$ ) when compared with its corresponding value measured at pre-treatment ( $3.58 \pm 0.33$ ) with  $t$  value= -4.739 and  $p$  value = 0.001. Also, the mean value of FVC was significantly increased at post-treatment ( $4.30 \pm 0.40$ ) when compared with its corresponding value measured at pre-treatment ( $4.10 \pm 0.40$ ) with  $t$  value= -3.214 and  $p$  value = 0.003. On the other hand, there was no statistical significant difference in FEV1/FVC ratio between the pre-treatment ( $85.26 \pm 5.27$ ) and post-treatment ( $85.67 \pm 5.14$ ) values ( $t$  value= -0.874 and  $p$  value = 0.390) (Table; Fig.).

As regards PEF, there was a statistical significant decrease in the mean value of PEF measured at post-treatment ( $8.53 \pm 1.91$ ) when compared with its corresponding value measured at pre-treatment ( $7.84 \pm 1.90$ ) with  $t$  value= -2.672 and  $p$  value = 0.013. As regards HR, there was a statistical significant increase in the mean value of HR measured at post-treatment ( $106.19 \pm 11.61$ ) when compared with its corresponding value measured at pre-treatment ( $77.63 \pm 9.83$ ) with  $t$  value= -12.795 and  $p$  value = 0.001. On the other hand, there was no statistical significant difference in the mean value of SPO<sub>2</sub> between the pre-treatment ( $95.93 \pm 2.06$ ) and post-treatment ( $96.37 \pm 1.88$ ) measurements ( $t$  value= -0.891 and  $p$  value = 0.381) (Table; Fig.).

The percent increase in FEV1, FVC, FEV1/FVC, PEF, HR and SPO<sub>2</sub> were 4.47%, 4.88%, 0.48%, 8.80%, 36.79% and 0.46%, respectively.

**Table:** Comparison between mean values of pft, sat and HR measured at pre- and post-exercise in the studied group.

|                            | Pre- exercise<br>(n= 50) | Post- exercise<br>(n= 50) | MD    | % change  | t value | p value    |
|----------------------------|--------------------------|---------------------------|-------|-----------|---------|------------|
| <b>FEV1 (L)</b>            | 3.58 ± 0.33              | 3.74 ± 0.37               | 0.16  | 4.47% ↑↑  | -4.739  | 0.001 (S)  |
| <b>FVC (L)</b>             | 4.10 ± 0.40              | 4.30 ± 0.40               | 0.20  | 4.88% ↑↑  | -3.214  | 0.003 (S)  |
| <b>FEV1/FVC (%)</b>        | 85.26 ± 5.27             | 85.67 ± 5.14              | 0.41  | 0.48% ↑↑  | -0.874  | 0.390 (NS) |
| <b>PEF (L/min.)</b>        | 7.84 ± 1.90              | 8.53 ± 1.91               | 0.69  | 8.80% ↑↑  | -2.672  | 0.013 (S)  |
| <b>HR (beat/min.)</b>      | 77.63 ± 9.83             | 106.19 ± 11.61            | 28.56 | 36.79% ↑↑ | -12.795 | 0.001 (S)  |
| <b>SPO<sub>2</sub> (%)</b> | 95.93 ± 2.06             | 96.37 ± 1.88              | 0.44  | 0.46% ↑↑  | -0.891  | 0.381 (S)  |

Data are expressed as mean ± SD.

MD= mean difference.

NS=  $p > 0.05$  = not significant.

S=  $p < 0.05$  = significant.

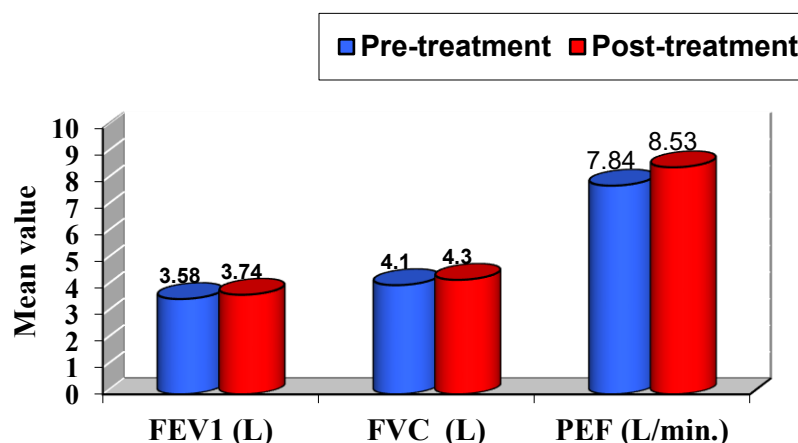


**Fig.:** Mean values of FEV1, FVC and PEF measured at pre- and post-treatment in the studied group.

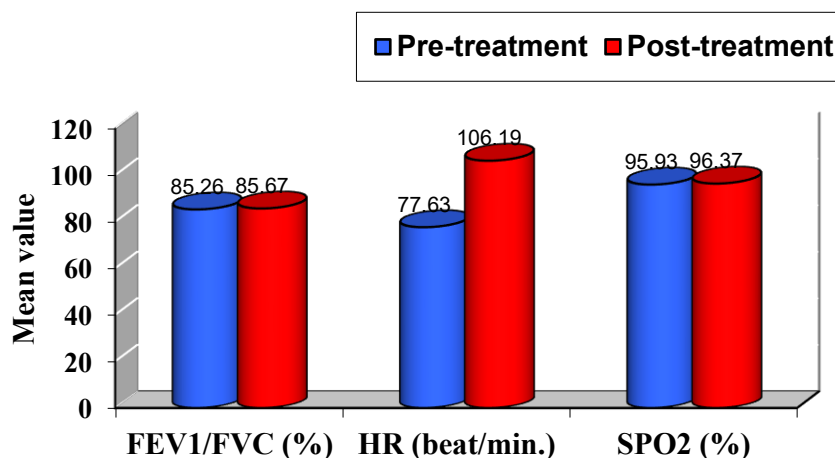


**Fig.:** Mean values of FEV1/FVC, HR and SPO<sub>2</sub> measured at pre- and post- exercise in the studied group.

## DISCUSSION

Several studies were done to investigate the effects of physical activities and sport exercise program on pulmonary function in patients with respiratory disorders. The results of these studies differed, which can be explained due to their variety in the exercise program, measurement tools, disease severity and environmental conditions.

This study is unique as it was performed to investigate the acute effect of exercise on ventilatory function and oxygen saturation on student and employee in the main campus of Kafr elsheikh University.

In current study; fifty men subjects participated in this study. they were recruited from the students and employs from the main campus Kafr elsheikh University. their ages ranged from 19 to 25 years old. All of them were classified according to BMI (18-33).

This study was conducted to assess the acute response of exercise on pulmonary function and oxygen saturation. This goal was accomplished through assessing the Correlation between both exercise and different pulmonary function parameters (FEV1, FVC, FEV1/FVC, PEFr).

### Regarding to the pulmonary function the result proved that:

As regards FEV1, there was a statistical significant increase in the mean value of FEV1 measured at post-treatment ( $3.74 \pm 0.37$ ) when compared with its corresponding value measured at pre-treatment ( $3.58 \pm 0.33$ ) with t value= -4.739 and p value = 0.001.

### Regarding Pulmonary Function and Oxygen Saturation:

In agreement with this study (Farid et al., 2005) examined the effects of a course of aerobic exercise on pulmonary function and tolerance of activity in asthmatic patients. They founded that a course of aerobic sport exercise causes an obvious increase in FEV1, FVC, PEF, FEF 25%-75% in asthmatic patients, and a regular aerobic sports program can be complementary to medical treatment in asthma rehabilitation.

This current study (Enright et al., 2006) stated that high intensity inspiratory muscle training results in increased contracted diaphragm thickness and increased lung volumes and exercise capacity in people who are healthy.

This result come in agreement with us (Khalili and Elkins, 2009) discussed the effect of aerobic exercise on lung function in children with intellectual disability. They stated that exercise had a small but statistically significant effect on lung function in children with intellectual disability.

A study conducted by (Dumus *et al.*, 2009) was aimed to evaluate the impact of two different home-based daily exercise programs on pulmonary functions in the patients with ankylosing spondylitis (AS). The results revealed that exercises are efficient in improving pulmonary functions.

Result from (Thaman et al., 2010) evaluated the effects of physical training and regular exercise on the lung functions in border security force trainees (BSF) in India. Their results showed that physical training and exercise improve the lung function parameters in BSF trainees after their training period.

Our finding line with (Hulke and Phatak, 2011) studied the effect of endurance training on lung function. They concluded that physical activity does improve some of lung function and also there is no deterioration in lung function with 12 weeks of exercise.

This study showed that (Costa et al., 2011) investigated the respiratory pattern of chronic obstructive pulmonary disease (COPD) patients during different upper limb exercises associated with respiratory exercises. They postulated that the inversion of inspiration/expiratory could probably be an interesting strategy for performing respiratory exercises associated with the upper limbs to minimize thoracoabdominal asynchrony in COPD patients. They recommended further studies to relate this strategy to the breathing retraining during upper limb exercises, which are also part of pulmonary rehabilitation and daily life activities.

In this study it was noticed by (Azad et al., 2011) that evaluation the effect of aerobic exercise training on improving lung function in overweight and obese students. They designed a 24 weeks of continuous treadmill running (three days a week)

exercise program. They stated that in overweight and obese teenagers, appropriate aerobic exercise training could partly improve lung function by strengthening the muscles of respiration.

In contrast, Clini et al (2002) did not find changes in either peak expiratory flow rate or FEV<sub>1</sub>. The changes we saw were specific to the training that is induced by the Power lung device. When blowing against the pressure gage, as in blowing against the Power lung, pressure is being exerted back against you. For this reason, we saw a significant increase in P<sub>ex</sub> in the training group. When blowing into the spirometer there is no resistance and it is different than the training of Power lung. For this reason, spirometry readings were not altered pre to post training.

In contrast, there are other studies Restrepo et al (2011) who reported preoperative training with IMT and deep breathing, observed that this type of intervention had no effect on postoperative lung volumes, their exercise was comparable with that of the present study, we are unable to draw conclusions from these trials about the level of supervision required because of the different modes and intensities of training employed.

On the other hand, Alison et al (2005), A recent meta-analysis regarding the effects of IMT on COPD patients showed that it promotes an increase in inspiratory muscle endurance and strength, reducing the sensation of dyspnea after exercise; however, no volume changes were reported. their training was comparable with that of the present study, however, this review was limited by the inclusion of studies that did not control for training intensity.

#### **There were different causes for the contradiction of some results of other studies:**

- 1- Other study was performed on other classes of Obesity.
- 2-The study was performed study on university students and staff who were healthy and perform daily physical activities on campus.
- 3-Other study was performed on different age groups.

#### **CONCLUSION:**

Acute exercise has a significant effect on ventilatory function and oxygen saturation in students and employees in the main campus of Kafr elsheikh University

#### **RECOMMENDATIONS:**

These study results recommended the following:

- 1- Using acute exercises program in the treatment of chest diseases.
- 2- Using acute exercises program in hypoxemia to improve O<sub>2</sub> sat.
- 3- Further studies are required:
  - a- To determine the impact of acute exercises on abnormal subjects.
  - b- To determine the impact of acute exercises on geriatric and pediatric subjects.

#### **Appendix (1):**

##### **Consent form**

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