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EVALUATION OF THE RELATIONSHIP BETWEEN LUNG FUNCTION AND ANTHROPOMETRIC PARAMETERS IN NORMAL HEALTHY VOLUNTEERS AND SPORT PERSONS

MOHIUDDIN M[1*], JALEELI KA[2] AND MISBAHUDDIN[3]

1: Department of Physiology, Rabigh College of Medicine, King Abdulaziz University, Saudi Arabia

2: Biophysics Unit, Department of Physics, Nizam College, Osmania University, Hyderabad, India

3: Department of Pharmacology, Rabigh College of Medicine, King Abdulaziz University, Saudi Arabia

***Corresponding Author: mohi_siddiq@yahoo.com; +966595553715**

ABSTRACT

Exercise physiology has become an increasingly important topic for research and discussion. Physical inactivity and sedentary lifestyles is linked to various chronic and metabolic diseases. Exercise has shown to increase muscular strength, decrease blood pressure, increase oxygen consumption and improve the cardiovascular / cardio-respiratory function. Lung function studies give a good estimate of the physical endurance and PEFR is one of the most sensitive parameters to assess lung function. In the present study mini wright's peak flow meter is used to assess the impact of exercise and athletic training on pulmonary function. The present study reveals that there is a significant increase in PEFR (Peak Expiratory Flow Rate) in athletes and other sportsmen compared to control group and also there is a significant correlation of weight, BMI (Body Mass Index) and BSA (Body Surface Area) to PEFR in sportsmen as compared to control group.

Keywords: Respiration, Exercise, PEFR, Lung, Athletes

INTRODUCTION

Physiology of exercise has become an increasingly important topic for research and discussion over the past few years. Exercises are being prescribed either to prevent the disease or as an adjuvant to a patient during convalescence and rehabilitation. Lack of exercise is linked to cancer, diabetes and cardiac disease causing around ten percent of death in the planet. Approximately 2 million deaths per year are attributed to physical inactivity, prompting WHO to issue a warning that a sedentary lifestyle could very well be among the leading causes of death and disability in the world **[1]**. Exercise has shown to increase muscular strength, reduce body fat and increase lean body mass, potentially decrease resting systolic and diastolic blood pressure, increase maximal oxygen consumption (VO2max), improve in cardiovascular / cardio-respiratory function (heart and lungs), increase maximal cardiac output, increase blood volume and ability to carry oxygen, increase blood supply to muscles and ability to use oxygen **[2]**.

The peak expiratory flow rate (PEFR) is a person's maximum speed of expiration. It measures the airflow through the bronchi and thus the degree of obstruction in the airways. The peak expiratory flow rate (PEFR) is a test that measures how fast a person can exhale **[3]**. With the introduction of the Mini Wright's peak flow meter devised and designed by BM Wright **[4]**, it has been in tremendous use in lung function studies and exercise physiology. This instrument is based on the assumption that the peak flow rate gives a reasonably accurate measurement of lung function. It was well evaluated by Perks **[5]**.

Recently, the American thoracic association (ATS) and European Union (EU) have conducted a comparison study with Mini Wrights peak flow meter in normal healthy volunteers and concluded that The ATS peak flow meter reads 2.8% higher than the EU peak flow meter across a range of flows. Both meters have similar accuracy **[6]**. In another study by Pesola et al in 2009, mini Wright versus spirometric predicted peak flows were compared and they found that Mini Wright peak flow values are slightly higher than spirometrically derived predicted peak flow values in subjects without lung disease **[7]**.

PEFR is affected by changes in broncho-pulmonary structure and function. Swaminathan *et al*.,1993 **[8]**, measured the Peak expiratory flow rate in healthy South Indian Children aged 4-15 years using the wright's Mini peak flow meter. They found lower PEFR values in Indian children which could be due to an effect of lower lung volumes due to a smaller chest size. A study by Rastogi *et al*., 2009, **[9]** in children having recurrent respiratory tract infection found altered PEFR in 67.6 percent patients. They also observed PEFR to be the most sensitive parameter to detect alteration in lung function. Moreover, a PEFR study done in normal healthy volunteers by De

AK *et al*., 2007, **[10]** found that the mean value of PEFR (L/min) was reduced from 523.67 ± 64.69 in 1982 to 471.44 ± 85.25 in 2004 in young adults in age groups of 20-25 years. They asserted that air-pollution and sedentary lifestyles in the population may be probable reasons for the decline in respiratory performance. PEFR is also affected by industrial exposure as evidenced from another study **[11]**.

Some studies on relationship of anthropometric parameters and PEFR were conducted in the past. An anthropometric study done by Saxena *et al*., **[12]** on healthy young male volunteers suggested that obesity itself and especially the pattern of body fat distribution have independent effects on PEFR. Moreover, the variations of Peak Expiratory Flow Rate (PEFR) with respect to height, weight and chest circumference was studied in a population of healthy adult Nigerians and they found a linear increase in PEFR with respect to the three anthropometric variables **[13]**. Another very recent study by Price *et al.*, **[14]** in Nigerian population showed a positive Correlation between PEFR and BMI for the overall population.

This study is designed to evaluate the anthropometric parameters and PEFR in healthy volunteers, athletes and other sportspersons; and to study the correlation between PEFR and anthropometric parameters in different study groups.

MATERIAL AND METHODS

After ethical clearance and written informed consent, the subjects (n=161) aged 18-20 years were divided into two groups namely the control group (n=52), and the experimental group comprising two sub-groups of the athletes (n=55) and the football players (n=54). Study subjects for control group were selected from a local college while the experimental group was taken from a local sports club by block randomization. The experimental group was undergoing vigorous training for 2 to 4 hours per day since 3 to 4 years at the time of conducting the study.

A complete history including past history, family history and treatment history was taken to exclude any possibility of genetic and acute or chronic diseases and recorded on a Performa (Appendix 1). Anthropometric data collection was done for each subject using standard methods. The participants' height and weight were measured using standard clinic scales and BMI calculated by the standard formula **[15]**. Body weight was calculated before and after exercise to detect possible excess water loss. Body surface area was calculated using Dubois chart **[16]**. Pulse rate and resting blood pressure were recorded by standard methods.

After detailed explanation regarding the working of the instrument (Appendix 2), proper demonstration and trial performance, a Mini Wright's Peak Flow Meter (Clement Clark's International England) was used to record PEFR by methods described previously **[17]**. Measurements were taken with the patient sitting upright, and the highest value of three peak expiratory flow rate maneuvers was recorded. Best of the three readings was taken for statistical analysis. The instrument was sterilized between uses by each subject using a dilute (10%) solution of Potassium Permanganate & Cotton Wool.

Statistical Analysis

All the values were expressed as Mean±SD. Independent t-test and ANOVA was used to compare the parameters in different groups. Pearsons correlation (r) between PEFR values and different parameters in control and experimental groups was also evaluated. P value of <0.05 was considered statistically significant. All the statistical analysis was done using SPSS ver. 17 for windows.

RESULTS

Out of 161, a total of 152 subjects completed the study. 3 participants from control group, 4 from athletes and 2 from the football group were lost to follow up.

Table 1 Shows the Mean height, weight, BMI and body surface area in control and experimental groups. The mean height of control group was 168.94 ± 3.37, while it was 175.15 ± 4.87 and 171.22 ± 4.98 in football and athletic groups respectively. Similarly, the control group had a mean weight of 60.25 kg, football group 61.45 kg and the athletic group 58.29 kg. The body surface area was almost equal in control and athletic group (1.66 and 1.67) while it was more (1.73) in football group. BMI was least in athletic group with a value of 19.89 ± 1.18, while it was slightly more (20.06 ± 1.07 and 20.57 ± 3.60) in football and control groups respectively. All the values were found statistically significant.

Table 2 shows the blood pressure and pulse rate of different groups. The systolic and diastolic blood pressure was 111.578 ± 15.64 and 77.14 ± 3.68 for control group, 107.37 ± 4.99 and 75.94 ± 2.47 for athletic group while it was 105.8 ± 5.23 and 76.1 ± 2.29 for football group. Only 3 subjects from athlete group and 2 subjects from football group were having systolic blood pressure greater than 110 mm Hg while more than 50% subjects from control group were having systolic blood pressure above 110 mm Hg. The pulse rate was also higher (79.67 ± 3.95) in control group as compared to football group (73.19 ± 3.85) and athlete group (68.88 ± 3.50) respectively.

Figure 1 shows the PEFR in different groups. The values are highest in football group (633.05) as compared to athlete (610.94) and control groups (558.98)

Table 3 shows the correlation of different variables with PEFR in different groups. All the parameters in different groups have a significant albeit weak correlation with PEFR values except weight and BMI in athletes which shows a moderate correlation.

Table 1: Depicting the Anthropometric Parameters in Different Groups

Groups	N	Height (cm) Mean ± SD	Weight (kg) Mean ± S.D.	B.S.A (m^2) Mean ± S.D.	B.M.I Mean ± S.D.
Control	49	168.94 ± 3.37 P< 0.05	60.25 ± 4.43 P< 0.01	1.67 ± 0.07 P> 0.05	20.57 ± 3.60 P> 0.05
Football	52	175.15 ± 4.87 P< 0.01	61.45 ± 2.09 P> 0.05	1.73 ± 0.05 P< 0.001	20.06 ± 1.07 P> 0.05
Athletes	51	171.22 ± 4.98 P< 0.05	58.29 ± 3.37 P< 0.05	1.66 ± 0.07 P< 0.05	19.89 ± 1.18 P< 0.01

Table 2: Blood Pressure and Pulse Rate in Different Groups

Groups	N	Blood Pressure (mm Hg) Systolic	Diastolic	Pulse rate
Control	49	111.578 ± 15.64 P> 0.05	77.14 ± 3.68 P>0.05	79.67 ± 3.95 p>0.05
Football	52	105.8 ± 5.23 P> 0.05	76.1 ± 2.29 P> 0.05	73.19 ± 3.85 p>0.05
Athletes	51	107.37 ± 4.99 P< 0.05	75.94 ± 2.47 P< 0.05	68.88 ± 3.50 P<0.05

Table 3: Correlation Between PEFR and Different Variables in Various Groups

Groups	N	Height	Weight	BMI	BSA
Control	49	0.1915 (p<0.001)	0.2915 (p<0.05)	0.1172 (p<0.05)	0.2564 (p<0.05)
Football	52	0.3266 (p<0.001)	0.0960(p<0.05)	0.2936 (p<0.05)	0.2330 (p<0.05)
Athletes	51	0.2367 (p<0.001)	0.5589 (p<0.05)	0.4853 (p<0.05)	0.4881 (p<0.05)

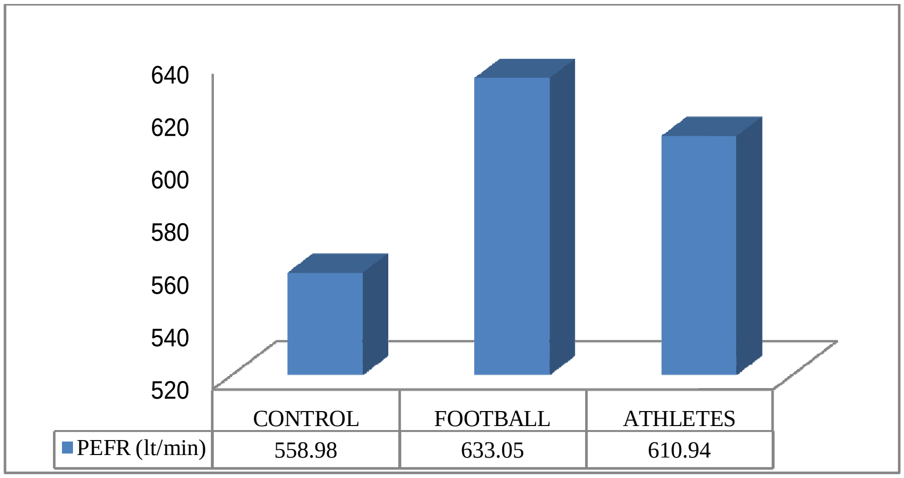

Figure 1: Peak Exploratory Flow Rates (lt/min) in Different Groups

DISCUSSION

In this study; the anthropometric, cardiovascular and respiratory parameters were studied in three different populations of normal healthy volunteers, athletes and football players. The anthropometric data was also correlated with the PEFR.

Regular physical activity contributes to the achievement and maintenance of good health. Continual moderate use of muscles, joints, bones and the heart keeps them in good working order and as a consequence, daily physical demands are met with less effort. There have been considerable benefits demonstrated resulting from an active life style and occupational activity.

Soma type is a medical description of size, shape and build. Every individual is different and not everyone is of the right size or shape to be competitive in every sport. Soma types grades athletes according to parameters of appearance into:

- **a)** Ectomorph: Tall thin individuals
- **b)** Endomorphs: Small, round type
- **c)** Mesomorph: Triangular man, muscular and broad shouldered.

Different sports require different skills and fitness in various modalities, which again depends on the Body Mass Index.

Table 1 shows that football players were having maximum height, weight as well as body surface area. This may be due to their strenuous physical activity and muscular built. They were mainly falling into ectomorphs and mesomorphs categories. Athletes were having the minimum BMI which corresponds to their regular long running exercises. These findings are in accordance with the previous studies **[18]**.

Table 2 depicts the cardiovascular parameters in different groups. There was no statistically significant difference in all the groups studied. The systolic pressure was not changed but the diastolic pressure was slightly reduced in experimental groups by 1-2 mm Hg. as compared to controls, but was not statistically significant. The Arterial Blood Pressure recorded was also in resting phase and not during exercise, or before the commencement of exercise.

Training generally does not affect the resting blood pressure of persons under 30 years if their fitness level is average and their blood pressure is normal at the start of training. The resting blood pressure will be significantly reduced, however in the middle-aged or older trainees (men, women) who start out with a below average fitness level and higher than normal blood pressure **[19]**. However, more experimentation like treadmill tests and other physical endurance tests with more sophisticated instruments are required to generate a good data on this aspect.

The Pulse rate showed a 13% decrease in resting pulse rate in athletes as compared to control group, and an 8% decrease in Football group which was highly statistically significant. Athletes, particularly endurance athletes, usually have a decreased heart rate (bradycardia) and an increased stroke volume while resting. Evidently the physical training that an athlete goes through increases the pumping performance of the heart, since, for a given cardiac output, a slower beating heart with a larger stroke volume represents more efficient energy utilization by the myocardium **[20]**. So our findings were in accordance with the previous studies which explained this phenomenon well.

Figure 1 shows the PEFR values in different groups. The PEFR in controls was 558.98 L/min. There was a maximum 13% increase in PEFR to 633 L/min. in Football Players and a 9% increase in athletes of 610.9 L/min. All these values of PEFR are statistically significant.

The Wright's peak flow meter has been used to test ventilator capacity in many epidemiological surveys, and in recent years it has been used increasingly by clinicians in outpatient departments, Chest Clinics, and in general practice **[21, 22]**.

Peak Expiratory flow rate (PEFR) is dynamic and dependent upon voluntary muscular effort of the subject. It is of value for the identification of chronic obstructive bronchitis, and for the assessment and follow up of patients with Bronchial Asthma.

Peak Expiratory flow rate showed a significant increase in athletes and sportsmen, as compared to controls. This increase in PEFR in various sportsmen indirectly indicated better lung elastic recoil, chest muscle power, and the total compliance of the chest wall and lungs, which were achieved because of physical training. The maximum increase in PEFR was found in football players due to their strenuous exercise.

Most of the lung volumes (Inspiratory and Expiratory reserve volumes, Residual volume, Total lung volume, and Vital capacity) are larger in athletes, than in non athletes of the same sex and body size. These changes may be a result of an increase in the strength of the skeletal muscles responsible for ventilation.

Table 3 shows the correlation coefficient (r) of PEFR with various parameters like Height, Weight, Body Mass Index and Body surface area in controls, footballers and athletes. The results showed a definite significant correlation of PEFR with all anthropometric data especially height. This finding is consistent with a previous study **[23, 24]**. Moreover the correlation between PEFR and weight is moderate which can be explained by the fact that exercise leading to increased muscular built will lead to more strong inspiratory & expiratory effort and better chest compliance leading to increase flow rates. This kind of association is also supported by previous studies **[13, 14]**. Persons possessing higher values of PEFR have the capacity of performing better in athletics.

CONCLUSION

There is a statistically significant increase in PEFR in athletes and other sportsmen compared to control group. There is no significant change in systolic blood pressure, though diastolic blood pressure showed a slight insignificant decrease in athletes and footballers. There is a definite bradycardia in athletes. There is a definite significant correlation of weight, BMI & BSA to PEFR in sportsmen.

Further studies with larger sample sizes and varied population of sportspersons in different age groups are needed to establish a definite relationship between lung function tests and anthropometry.

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