

CORRELATION OF PULMONARY FUNCTION TESTS WITH BODY FAT PERCENTAGE IN YOUNG INDIVIDUALS

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Abstract : The present study was planned to assess the correlation of pulmonary functions with body fat percentage in young individuals. A total of 132 (males-68, females-64) young students (18 to 21 years) with moderately sedentary lifestyle were recruited in this study. Their height, weight, body mass index (BMI) and waist to hip ratio (WHR) were measured. Pulmonary function tests (static and dynamic) were recorded on a computerized portable Schiller lung function unit SP-1. The percentage of body fat was estimated by measuring skin fold thickness at four sites (4SFT-biceps, triceps, subscapular and suprailiac) with the help of Harpenden's caliper. In males body fat % showed negative correlation with expiratory reserve volume (ERV), forced vital capacity (FVC), maximum ventilatory volume (MVV), peak expiratory flow rate (PEFR) and forced expiratory volume at the end of first second (FEV₁). It was observed that in females body fat % had negative correlation with ERV, FVC, and MVV. These results indicate that increase in percentage of body fat and central pattern of fat distribution may affect the pulmonary function tests.

Key words : body mass index
body fat percentage

pulmonary function tests
skin fold thickness

INTRODUCTION

The magnitude of the upswing in overweight and obesity prevalence has been truly astonishing (1). It has now become an important health problem in developing countries particularly in India (2). The consequences of industrialization and urbanization, which lead to decrease in physical activity, together with substantial dietary changes and overall pattern of life

style, promote weight gain. Although all risks associated with increasing weight are aggravated in persons with body mass index (BMI) > 40 kg/m², a BMI between 25 and 30 kg/m² should be viewed as medically significant and worthy of therapeutic intervention especially in the presence of risk factors. The influence of increased percentage of body fat (body fat >35%) and central obesity on blood pressure and glucose intolerance has been well documented (3, 4).

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Most of the studies regarding the effect of obesity on pulmonary function tests have been conducted in males, in the age group of 5 to 16 years or they have been carried out in the elderly age groups (5, 6). These studies have not considered the percentage of body fat and the pattern of fat distribution which also can affect the pulmonary function. Thus, the purpose of this study was to evaluate the association of pulmonary functions (static and dynamic) with the percentage of body fat in young Indian students.

METHODS

The study was conducted in 132 student volunteers (68 males and 64 females) in the age group of 18–21 years with body mass index (BMI) 18.5 to 29.9 kg/m².

All the volunteers were physically healthy, without any symptoms. They were evaluated as per standard proforma which included a questionnaire. The experimental protocol was explained to all the student volunteers and written informed consent was obtained from them. The Institutional ethical committee approved the study.

Students doing regular exercise, having obstructive or restrictive type of respiratory diseases and taking treatment for the same or having metabolic disorders related to obesity were excluded from the studies. All anthropometric measurements were obtained in the volunteers wearing light-weight clothing, and barefoot. All measurement procedures were as per the protocol described in Helsinki Declaration. Standing height was measured to the nearest 0.1 cm. Body weight was recorded in

kilograms on an empty bladder and before lunch on a standardized weighing scale. The weight measurement was recorded to the nearest 0.1 kg. The waist circumference (cm) was measured at a point midway between the lower rib and iliac crest, in a horizontal plane. The hip circumference (cm) was measured at the widest girth of the hip. The measurements were recorded to the nearest 0.1 cm. Body mass index was calculated by Quetelet's Index (7).

The study was undertaken in four groups. Volunteers having BMI 18.5 to 24.9 kg/m² formed the control groups for males and females (34 males and 32 females) and volunteers having BMI 25 to 29.9 kg/m² formed the overweight groups for males and females respectively.

The percentage of body fat was estimated by using the method of Durnin and Womersley (8). For measuring the skin fold thickness at four different sites on the left side of the body, skin fold caliper was used. Extremity skinfolds were measured at the triceps and biceps and trunk skinfolds were measured at the suprailiac and subscapular areas (8, 9). The skin fold was picked up between the thumb and the forefinger and the readings were taken 5 seconds after the caliper was applied. Three consecutive readings were taken and recorded at each site. The difference was not more than 2 mm between them. The average of the three readings at each site was calculated and the sum of these values was entered into the table given by Durnin and Womersley (8).

Pulmonary functions were recorded on a computerized portable Schiller lung function unit SP-1(RS 232). The recorded parameters

were compared with the inbuilt pulmonary function norms for the Indian population depending upon the age, sex, height, and weight. The spirometer was calibrated daily using calibration syringe of 2 liters. Recording of static and dynamic pulmonary function tests was conducted on motivated young healthy volunteers in standing position (10).

These tests were recorded at noon before lunch, as expiratory flow rates are highest at noon (11). For each volunteer three satisfactory efforts were recorded according to the norms given by American Thoracic Society (12). The essential parameters obtained were, tidal volume (V_T), expiratory reserve volume (ERV), inspiratory capacity (IC), forced vital capacity (FVC), timed vital capacity (FEV_1), maximum ventilatory volume (MVV) and peak expiratory flow rate (PEFR). All the records i.e. anthropometric measurements, skin fold measurements and recording of pulmonary function tests were conducted in one sitting on the same day.

Analysis of data

The ventilatory lung function tests were compared in both the normal and overweight groups by the 'unpaired t' test. Data were expressed as Mean \pm SD. Statistical significance was indicated by 'P' value <0.05 . Correlation of ventilatory lung function tests with body fat percentage was noted by using Pearson's correlation coefficient test. The non zero values of 'r' between -1 to 0 indicate negative correlation.

RESULTS

The anthropometric parameters of the male and female groups are given in Table I. In the present study age and height of the subjects were homogenous. There was significant difference in the waist to hip ratio and percentage body fat.

The observed values of various lung function parameters are provided in Table II. In males and females overweight groups

TABLE I: Comparison of Mean \pm SD values of anthropometric parameters of four groups of the volunteers.

Parameters (n)	Males		Females	
	Control (34)	Overweight (34)	Control (32)	Overweight (32)
Age (years)	18.02 \pm 3.27	18.73 \pm 3.02	18.34 \pm 1.06	17.25 \pm 1.54
Height (cm)	172.50 \pm 7.01	173.00 \pm 4.12	160.50 \pm 6.02	164.05 \pm 1.34
Weight (kg)	66.79 \pm 5.80	77.90 \pm 6.71	63.70 \pm 5.64	68.40 \pm 7.90
BMI	22.30 \pm 1.56	27.37 \pm 1.27	21.30 \pm 1.52	26.70 \pm 1.50
WHR	0.83 \pm 0.14	0.93 \pm 0.05*	0.84 \pm 0.05	0.89 \pm 0.16*
Skin fold thickness (mm)				
Biceps	10.36 \pm 4.22	13.84 \pm 6.42	12.00 \pm 4.63	14.25 \pm 7.18
Triceps	12.92 \pm 4.60	20.09 \pm 6.33	16.54 \pm 4.62	22.31 \pm 5.42
Subscapular	18.61 \pm 5.02	28.72 \pm 7.1	22.29 \pm 8.1	28.26 \pm 7.46
Suprailiac	22.50 \pm 6.72	30.86 \pm 7.4	27.82 \pm 7.39	32.31 \pm 7.44
Body fat %	23.35 \pm 2.91	28.41 \pm 2.92*	31.99 \pm 3.92	34.53 \pm 1.75*

*P <0.05 unpaired 't' test; Body Fat % - calculated by Durnin and Womersley method.

TABLE II: Comparison of Mean±SD values of pulmonary function tests amongst the control and overweight groups.

Parameters	Males		Females	
	Control	Overweight	Control	Overweight
V _T (L)	0.48±0.09	0.46±0.09	0.37±0.11	0.35±0.10
ERV (L)	0.80±0.15	0.73±0.10*	0.59±0.14	0.51±0.18*
IC (L)	3.10±0.51	3.05±0.71	2.68±0.31	2.62±0.32
FVC (L)	3.96±0.69	3.70±0.40*	3.15±0.41	2.99±0.30*
FEV ₁ /FVC	0.79±0.03	0.80±0.03	0.76±0.02	0.79±0.02
MVV (L/min)	126.23±24.08	115.30±19.11*	81.16±10.33	74.50±14.54*
PEFR (L/min)	456.40±115.33	424.10±107.61	385.42±33.34	369.41±35.11

*P<0.05 Student 't' test; unpaired observations.

expiratory reserve volume (ERV), forced vital capacity (FVC), and maximum ventilatory volume (MVV) were decreased significantly (P<0.05). It was observed that body fat % in males group had no correlation with tidal volume (V_T) and inspiratory capacity (IC). Interestingly in males group body fat % showed significant negative correlation with ERV (r = -0.84), FVC (r = -0.54), MVV (r = -0.58), PEFR (r = -0.43), and FEV₁ (r = -0.50). It is seen that body fat % in females also had negative correlation with ERV (r = -0.54), FVC (r = -0.46), MVV (r = -0.40) and PEFR (r = -0.31) and no correlation with V_T, IC and FEV₁.

DISCUSSION

Present study demonstrated the relationship of pulmonary functions with body fat percentage in a group of young volunteers. A significant negative correlation of ERV with body fat % in males and females was observed indicating that ERV diminishes in inverse proportion of percentage body fat.

As stated earlier, the reduced values of

ERV were due to the increased fat percentage. It is an established fact that ERV contributes to the amount of FRC, VC and TLC. In this study, FVC correlated inversely with body fat % in both the male and female groups. The observed values of decreased FVC suggested displacement of air by fat within the thorax and abdomen.

In our study in the males group, FEV₁ showed negative correlation with body fat %. Both FEV₁ and FVC are the lung functions most closely related to body composition and fat distribution. It has been also stated that increase in adult body mass is a predictor of FEV₁ decline (13). The normal FEV₁/FVC ratio in our study indicates that the inspiratory and expiratory muscle strength is normal (14).

The present data shows that increased body fat % in the males and females have negative correlation with ERV and FVC (static tests) and MVV (dynamic tests). The negative correlation of increased percentage of body fat and FEV₁ was observed only in males as reported earlier (15-17).

Body mass index has been proposed to analyze the effects of increased weight on pulmonary function tests, but its use is only valid for lung function indices where the contribution of fat and muscles are synergistic. Thus evaluation of the change in pulmonary function in overweight subjects should be done by estimating body fat percentage.

Indians are considerably obese at a relatively low BMI (2). Body fat usually constitutes 15 to 20% of body mass in healthy men and 25 to 30% in healthy women. In this study although BMI of the control group volunteers was within normal range the observed body fat percentage was on the higher side (18).

Waist to hip ratio (WHR) is highly correlated with abdominal fat mass and is therefore; often used as a surrogate marker for abdominal or upper body obesity. The predicted normal WHR in men is 0.93 and in women it is 0.83. In our study in both the groups of males and females central pattern of fat distribution was observed and all the ventilatory function parameters per se in

each group were within the predicted normal range.

The amount of body fat and a central pattern of fat distribution might be related to lung function via several mechanisms, such as mechanical effects on the diaphragm (impeding descent into the abdominal cavity) and on the chest wall primarily due to the changes in compliance and in the work of breathing and the elastic recoil (19).

The study suggests that increase in body fat % and central fat distribution is associated with a modest decrease in the static (ERV, FVC) and dynamic (MVV, FEV₁) tests in overweight individuals. Although the magnitude of the effect is relatively small from a public health perspective, our findings in the present study indicate the consequence of increased body fat % on lung function.

A larger sample size and a longitudinal study will definitely be of a great value in predicting the relationship between pulmonary function tests and body fat percentage.

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