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Correlation of FEV1, FVC, & FEV1/FVC % with Body Fat Percentage in College Students of Dharwad City

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ABSTRACT

Background- Obesity is a growing problem even in developing regions like India. Obese people are also at risk for social discrimination and possibly adverse psychological consequences. **Objective**: to study dynamic lung functions and flow rates Forced Expiratory Volume (FEV), Forced Ventilatory Capacity (FVC), FEV1/FVC ratio on subjects and controls. **Methods**- The study was conducted in the Department of Physiology, SDM College of medical sciences and hospital, Dharwad. 150 male students in the age group 15-24 years of the college formed the subjects of the study. **Results**- The mean (±SD) body mass index in overweight group was 23.94 ± 0.55kg/m^2, in obese group was 26.81 ± 1.45kg/m^2 and in controls was 21.04 1.26 kg/m^2. The mean (±SD) age in overweight group was 20.44 ± 1.83 years, in obese group was 20.60 ± 1.78 years and in controls was 19.90 ± 1.31years. The mean (± SD) forced vital capacity at rest in overweight group was 3.54 ± 0.37 litres, in obese group was 3.53 ± 0.76 litres and in controls was 3.82 ± 0.46 litres. The mean (± SD) FEV_1 at rest in overweight group was 3.11 ± 0.40 litres, in obese group was 3.10 ± 0.73 litres and in controls was 3.43 ± 0.5 litres. The mean (± SD) FEV_1/ FVC at rest in overweight group was 0.87 ± 0.37 %, in obese group was 0.87 ± 0.03% and in controls was 0.89 ± 0.06%.

Conclusion- FEV_1 and FVC were significantly lower in overweight and obese groups compared to controls. FEV_1 was reduced more significantly than FVC. But there is no significant change in FEV_1/FVC ratio in overweight and obese groups.

Keywords: *Forced Vital capacity (FVC), Forced Expiratory Volume in first second (FEV_1), FEV_1/FVC, BMI*

INTRODUCTION

Physiologic system, orchestrated through endocrine and neural pathways, permits humans to survive starvation for as long as several months[1]. However in the presence of nutritional abundance and a sedentary life style, & influenced importantly by genetic endowment, this system increases adipose energy stores resulting in obesity that produces adverse health consequences[2]. Adipose tissue accounts for about 20% of the total body weight of a normal young adult, about 15kg in the average person.

The WHO consultation on obesity, Geneva interim report on "obesity-preventing and managing the global epidemic1997: has recognized that overweight and obesity represent a rapidly growing threat to the health of population worldwide. It recognized obesity as a disease, which is prevalent in both developing and developed countries and affects children and adults alike. Indeed obesity and overweight are so common that they are replacing the more traditional public health concern such as under nutrition and infectious diseases as some of most significant contributes to ill health.

There are different measures to assess obesity. One of the most commonly used is Body Mass Index (BMI)

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which is a measure of general obesity[3]. Indices used to measure regional and central obesity are subscapular skin fold thickness, waist circumference and abdominal sagittal diameter and ratios like Waist-Hip ratio (WHR). These have been considered as better and more sensitive than BMI[4].

On the other end of the spectrum purely mechanical consequences of obesity like various forms of hypoventilation syndrome and dramatic reduction in various lung volumes have also been established[5]. Hence the present study is taken up to study dynamic lung functions and flow rates Forced Expiratory Volume (FEV), Forced Ventilatory Capacity(FVC), FEV1/FVC ratio on subjects and controls

MATERIALS AND METHOD

The study was conducted under the auspices of the laboratory set up of the Department of Physiology, SDM college of medical sciences and hospital, Dharwad. 150 male students in the age group 15-24 years of the college formed the subjects of the study with applying exclusion criteria i.e Those with history of smoking or atopy, asthama, BMI <18.5 or >29.9, History or family history of asthama, Congenital cardiopulmonary disease and age <15 or >25 years

These subjects were divided into three groups based on BMI as follows.

GpI (Controls) : 50 controls BMI 18.5-22.9(age and sex matched)

Gp-II (Overweight) : 50 students with BMI 23-24.9

Gp-III (Obese) : 50 students with BMI 25-29.9[3]

Method of data collection: Identification data name, age, sex and address were recorded. Age was calculated in years to the nearest birthday. Height and weight of each subject was recorded. BMI (Body Mass Index) was calculated using the formula BMI = Weight in Kg. / [Height in m]^2

- A detailed clinical examination of Respiratory, Cardio-Vascular and Central Nervous Systems was done.

- Skinfold thickness was measured at chest, abdomen, thigh regions using skin fold callipers, body fat percentage is calculated using Jackson and pollock's formula.

  o Three skinfold sites (chest, abdoman and thigh sites from above, SUM3 is the sum of these sites in mm)

  o Bone Density = 1.093800 - (0.0008267 * SUM3) + (0.0000016 SUM3²) - (0.0002574 Age)

  o Body Fat Percentage = [(4.95/Bone Density) - 4.5] 100

- Lung Function Tests were recorded using Spirovit SP-1.

Spirovit SP-1:

The instrument used in this study was Spirovit SP1 manufactured by Schiller. Its a type of flow sensing Spirometer. This is a low cost high performance instrument capable of giving highly accurate and repeatable test results and represents the major advancement in computerized pulmonary function testing. It is best instrument for routine screening of large number of subject.

a. Forced Vital Capacity (FVC)

b. Forced Expiratory Volume in First Second (FEV_1)

c. Forced Expiratory Volume in first second to FVC ratio (FEV1/FVC)

Procedure: All maneuvers were performed in sitting position and at rest with the nose clip in place. The subject was asked to loosen tight clothing, if any. Each student was taught about the various maneuvers to be performed for about 5 minutes. Demonstration was also given. Every subject was given ample time to understand carefully and then was allowed to do some practice blows. Sufficient rest was provided between the procedures. Given below are the ways in which the subject was instructed to perform the three maneuvers.

o **FVC maneuver** – A disposable card board mouth piece was placed in the pneumotachograph. The 'FVC' button on the menu pad was pressed (with the sensor still on the stand). After sufficient rest was given the subject was asked to place the mouth piece properly. The start/stop button was pressed and the subject was asked to inhale completely and then exhale it forcefully and completely, this was followed by another complete inhalation, then the start/stop key was pressed again to stop the test. This test has three memories. The LCD screen displays both the PFT parameter results, as well as the flow volume loop.

Table no.1: Interpretation of Spirometry values[6]

Parameters	Restrictive	Obstructive
FVC	< 80% of predicted	Normal or < 80% of predicted
FEV_1	Normal or < 80% of predicted	< 80% of predicted
FEV_1/FVC	≥ predicted	< predicted

o According to recommendations of global initiative for COPD, FEV_1/FVC of 70% or less is defined as obstructive lung diseases**.**

o These values (FVC, FEV_1, FEV_1/FVC) were compared with average predicted for a subject on the basis of age, sex, built and race[7]

o In both the groups (test and control) subjects were highly motivated and cooperative. They performed the tests with care and maximum efforts.

Statistical analysis: Following statistical methods were employed in the present study using SPSS-20. Anova - Compares mean values of more than two groups. Correlation analysis

Findings**:** The Anthropometric data in overweight, obese and controls are shown in table 2.

Table 2. Anthropometric data of controls, oveweight and obese groups

Parameter	Control Mean ± SD (n=50)	Overweight Mean ± SD (n=50)	Obese Mean ± SD (n=50)	'p' value	Significance
Age(yrs)	19.90 ± 1.31	20.44 ± 1.83	20.60 ± 1.78	0.090	NS
Height(cm)	170 ± 7.2	170 ± 6.1	168 ± 6.1	0.121	NS
Weight(kg)	60.80 ± 4.84	69.44 ± 4.35	75.72 ± 8.11	0.000	S
BMI(kg/m^2)	21.04 ± 1.26	23.94 ± 0.55	26.81 ± 1.45	0.000	S
WHR	0.83 ± 0.03	0.86 ± 0.028	0.85 ± 0.04	0.000	S
BFP	19.11 ± 3.77	24.13 ± 1.95	26.35 ± 3.74	0.000	S

The mean (±SD) age in overweight group was 20.44 ± 1.83 years, in obese group was 20.60 ± 1.78 years and in controls was 19.90 ± 1.31years. The mean (±SD) height in overweight group was 170 ± 6.1cms, in obese group was 168 ± 6.1cms and in controls was 170 ± 7.2cms. There was no statistically significant difference of age and height between the three groups.

Weight: The mean (± SD) weight in overweight group was 69.44 ± 4.35 kgs, in obese group was 75.72 ± 8.11 kgs and in controls was 60.80 ± 4.84kgs. As BMI is the basis of division all three groups, they have significantly increasing weight with increasing BMI.

Body Mass Index (BMI): The mean (±SD) body mass index in overweight group was 23.94 ± 0.55kg/m^2, in obese group was 26.81 ± 1.45kg/m^2 and in controls was 21.04 ± 1.26 kg/m^2. As BMI is the basis of division so all three groups have significantly different BMI.

Waist Hip Ratio (WHR): The mean (±SD) waist hip ratio in overweight group was 0.86 ± 0.028, in obese group was 0.85 ± 0.04 and in controls was 0.83 ± 0.03. WHR is significantly more in obese and overweight groups compared to controls.

Body Fat Percent (BFP): The mean (±SD) body fat percent in overweight group was 24.13 ± 1.95 %, in obese group was 26.35 ± 3.74 % and in controls was 19.11 ± 3.77%. BFP is significantly more in obese and overweight groups compared to controls and also in obese group compared to overweight group.

Dynamic Lung Function: FVC parameters of Controls, overweight and obese groups are shown in Table 3.

Table 3. Dynamic lung function of controls, overweight and obese groups

Parameters	Control Mean ± SD (n=50)	Overweight Mean ± SD (n=50)	Obese Mean ± SD (n=50)	'p' value	Significance
FVC (L)	3.82 ± 0.46	3.54 ± 0.37	3.53 ± 0.76	0.017	S
FEV1 (L)	3.43 ± 0.54	3.11 ± 0.40	3.10 ± 0.73	0.007	S
FEV1/FVC (%)	0.89 ± 0.06	0.87 ± 0.37	0.87 ± 0.03	0.081	NS

Forced Vital capacity (FVC): The mean (± SD) forced vital capacity at rest in overweight group was 3.54 ± 0.37 litres, in obese group was 3.53 ± 0.76 litres and in controls was 3.82 ± 0.46 litres. FVC was significantly less in overweight and obese groups compared to controls.

Forced Expiratory Volume in first second (FEV_1): The mean (± SD) FEV_1 at rest in overweight group was 3.11 ± 0.40 litres, in obese group was 3.10 ± 0.73 litres and in controls was 3.43 ± 0.5 litres. FEV_1 was significantly less in overweight and obese groups compared to controls table 4.

Table 4. Correlation of WHR with PFT

Parameters	"r" value	"P"value
FVC (L)	- 0.228	0.005*
FEV1 (L/min)	- 0.262	0.001*
FEV1/FVC (%)	- 0.225	0.006*

FEV_1/FVC: The mean (± SD) FEV_1/FVC at rest in overweight group was 0.87 ± 0.37 %, in obese group was 0.87 ± 0.03% and in controls was 0.89 ± 0.06 %. There was no statistically significant difference among three groups.

DISCUSSION

Forced Vital capacity (FVC): The mean (± SD) forced vital capacity at rest in overweight group was 3.54 ± 0.37 litres/sec, in obese group was 3.53 ± 0.76 litres/sec and in controls was 3.82 ± 0.46 litres/sec. FVC was significantly less in overweight and obese groups compared to controls. FVC tend to decrease with increasing BMI[8,9]. However, the effect is small, and both FEV1 and FVC are usually within the normal range in healthy, obese adults[10].

Forced Expiratory Volume in first second (FEV_1): The mean (± SD) FEV_1 at rest in overweight group was 3.11 ± 0.40 litres/sec, in obese group was 3.10 ± 0.73 litres/sec and in controls was 3.43 ± 0.5 litres/sec. FEV_1 was significantly less in overweight and obese groups compared to controls. FEV1 tend to decrease with increasing BMI[8, 9]. However, the effect is small and both FEV1 and FVC are usually within the normal range in healthy, obese adults[8] and children[10].

FEV_1/FVC: The mean (± SD) FEV_1/FVC at rest in overweight group was 0.87 ± 0.37, in obese group was 0.87 ± 0.03 and in controls was 0.89 ± 0.06. There was no statistically significant difference among three groups. Both FEV_1 and FVC were similarly reduced (in terms of percentage predicted), the FEV_1 to FVC ratio was normal and static lung volumes were reduced, suggesting the reduction may be due to restriction as opposed to air flow obstruction[11]. The FEV1 to FVC ratio is usually well preserved or increased[12,9,] even in morbid obesity [13] , indicating that both FEV1 and FVC are affected to the same extent[10]. The normal FEV1/FVC ratio in our study may also indicate that the inspiratory and expiratory muscle strength is normal[13].

FVC and FEV1 results are consistent with previous studies done by Helena Santana et.al[14], senmann[15], 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[8]. The normal FEV1/FVC ratio in our study indicates that the inspiratory and expiratory muscle strength is normal[13]. Both FEV_1 and FVC were similarly reduced (in terms of percentage predicted), the FEV_1 to FVC ratio was normal and static lung volumes were reduced, suggesting the reduction may be due to restriction as opposed to air flow obstruction[11].

FEV1 and FVC, tend to decrease with increasing BMI[8,9] . However, the effect is small, and both FEV1 and FVC are usually within the normal range in healthy, obese adults [8] and children. The FEV1-to-FVC ratio is usually well preserved or increased[8] even in morbid obesity1[9], indicating that both FEV1and FVC are affected to the same extent. This finding implies that the major effect of obesity is on lung volumes, with no direct effect on airway obstruction.

Lazarus et al[20] found that the FEV_1 to FVC ratio decreases with increasing BMI in overweight and obese individuals. In morbidly obese subjects (defined as individuals with a body weight (in kilograms) to height (in centimetres) ratio greater than 0.9 (in kg/sqcm), Biring et al[19] found a reduction in midexpiratory flows and the FEV_1 to FVC ratio. Therefore, it appears that spirometric abnormalities in patients with mild to moderate obesity represent a restrictive defect placed on the system whereas with severe and morbid obesity, it represents true air flow obstruction. The mechanism may be related to small airway collapse due to decreased lung volumes with increasing obesity or it may be independent[11].

CONCLUSION

Dynamic lung volumes (FEV_1 and FVC) were significantly lower in overweight and obese groups compared to controls. FEV_1 was reduced more significantly than FVC. But there is no significant change in FEV_1/FVC ratio in overweight and obese groups.

Conflict of Interest*:* None to declare

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Ethical Clearance*:* Permission for the study was obtained from the College authorities prior to commencement.

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