Forced Vital Capacity (FVC) and Forced Vital Capacity in 1st Second (FEV_1) of Apparently Healthy Non-smoker Adult Obese

*Zahid AZ,[1] Sarkar CR[2]

Obesity is the leading nutritional disorder worldwide. Obesity leads to various complications such as hyperlipidemia, hypertension, type 2 diabetes mellitus, coronary artery disease, heart failure, stroke, renal failure, gall bladder disease, peripheral vascular disease, certain types of cancer including pulmonary functions disorder. This cross sectional study was conducted in the Department of Physiology, Rangpur Medical College, Rangpur. FVC and FEV_1 were measured for assessment of lung function. The experimental subjects (apparently healthy non-smoker adult obese) were selected from medical students of different sessions. Age matched control subjects (apparently healthy non-smoker adult non obese) subjects were also taken from medical students. FVC and FEV_1 were significantly lower in experimental subjects and most of them showed restrictive pulmonary function disorder.

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Key words: Forced vital capacity, lung, non-smoker, FVC and FEV_1

Introduction

Obesity generally resulting from increased energy intake relative to energy expenditure. Fast food and alcohol, physical inactivity, decrease metabolic rate and some endocrine factors are responsible for obesity. It also has a strong genetic component. Prevalence of obesity has been increasing both in developed and developing countries. [1, 2]

A number of weight-for-weight indices have been developed of which BMI is the most widely used parameters for the assessment of obesity. Classification of weight by BMI in adult Asian as follows.[3]

Classification	BMI (Kg/sq. m)	Risk of co-morbidities
Underweight	< 18.5	Low
Normal rang	18.5 – 22.9	Average
Overweight	> 23	
- At risk	23 – 24.9	Increased
- Obese I	25 – 29.9	Moderate
- Obese II	> 30	Severe

1. *Dr. A.T. M. Zoadur Rahim Zahid, Associate Professor, Physiology, Rangpur Medical College, Rangpur. drzahid63@gmail.com
2. Dr. Chandra Rani Sarker, Professor, Physiology, Rangpur Medical College, Rangpur

* For correspondence

Obesity has some negative effects on lung function.[4] Common lung function disorders are obstructive and restrictive. In obstructive disorder airway resistance to airflow increase and impaired expiration. In restrictive disorder lung parenchymal resistance increase and reduced lung expansion and impaired inspiration.[5] Important ventilatory parameters for assessing lung functions are FVC, FEV_1, FEV_1% and PEFR. FRC and TLC also measured for lung function assessment. [6]

FVC (Forced Vital capacity) – is the maximum amount of air that can be expired forcefully after taking a most forceful inspiration. FEV_1 (Forced Expiratory Volume in 1st Second) – is the volume of forced expiratory flow in 1st second. FEV_1% (Percentage of Forced Expiratory Volume in 1st second) - is the ratio of FEV_1 to FVC expressed in percentage. PEFR (Peak Expiratory Flow Rate) – is the maximum rate of forced expiratory out flow. FRC (Functional Residual Capacity) – is the amount of air that remains in the lungs at the end of normal expiration. It is the combination of tidal volume and expiratory reserve volume. TLC (Total Lung Capacity) – is the maximum volume of air that remains in the lung after a most forceful inspiration. It is the total of tidal volume, inspiratory reserve volume, expiratory reserve volume and residual volume.[7]

Predicted or normal value of lung function parameters can be calculated by predicted equation and it depends upon individual age, sex, height, weight and ethnicity. Predicted value, actual value and percentage of predicted value of lung function parameters can me measured by Spirometer. In obstructive disorder primarily FEV_1 impaired and in restrictive disorder primarily FVC impaired. Lung function impairment less than 80% of predicted value is significant.[8] Functional Residual Capacity (FRC) and Total Lung Capacity (TLC) are increased in obstructive disorder and decreased in restrictive disorder of lung.[9]

Obesity can reduce respiratory well-being, even in the absence of specific respiratory disease. Obesity causes imbalance between inflationary and deflationary pressures of the lung and induce hypoventilation syndrome. Obese are at increased risk of respiratory symptoms, such as breathlessness, particularly during exercise. Obesity increases oxygen consumption and carbon dioxide production. Effects of obesity on lung and chest wall compliance stiffens the respiratory system and increases the mechanical work needed for breathing. Mechanical effects of obesity on the respiratory system contribute to airway dysfunction and reduce FEV_1. In obese people, the presence of adipose tissue around the rib cage and abdomen and in the visceral cavity loads the chest wall and reduction in the downward movement of the diaphragm. Thus reduce room for lung expansion on inflation of lung and decrease TLC, FRC and FVC. Deposition of fat in subpleural space of obese might directly reduce lung volume by the volume of chest cavity. [4]

Incidence of obesity is increasing in our country. Usually every obese people are not fully aware about various complications of obesity. So the present study was designed to observe FVC and FEV_1 in obese subjects whose BMI is above 25. This study may help to create awareness among the obese regarding lung function impairment. Thus earlier diagnosis and proper management of pulmonary complications can be possible and prevention of obesity by consuming balanced diet and regular physical exercise can be beneficial for them.

Methods

This cross sectional study was conducted from January 2013 to June 2013 in the Department of Physiology, Rangpur Medical College, Rangpur. Apparently healthy 30 non-smoker obese (BMI > 25) male and female medical students of different sessions, age 18 – 30 years were taken as experimental in Group – A. Age matched 30 apparently healthy non-smoker non-obese (normal weight - not under weight or nor over weight, BMI not < 18.5 and not > 23) male and female medical students were also taken as control in Group – B. They were randomly selected from different sessions of Rangpur Medical College and Northern (Pvt) Medical College, Rangpur. They are belonging to middle socioeconomic status. They have no history of asthma, any acute or chronic lung infection, heart disease, renal insufficiency and having no structural chest deformity. Aims and objectives of the study were explained to the selected students and their written consents were also taken. A standard questionnaire was filled after taking history and thorough clinical examination. Height and weight were measured for calculation of BMI and also for spirometric measurement of lung function parameters. Students were requested to wear light and loose cloth on the day of spirometric measurement. The detailed procedures were explained and demonstrated to them. They were asked to take rest and remain calm and quiet for five minutes. Spirometric measurement was done in standing position. The spirometer was switched on and age, height, weight of selected subject was inputted. Subject was instructed to inhale as much as possible. After closing the nose with a nasal clip, he was asked to exhale as forcefully as possible into the mouth piece by holding it in hand, approximately horizontally and to put the lips tightly around the outside of the mouthpiece. In between the maneuver, subjects were allowed to take rest for two minutes. This maneuver was performed for several times for each subject. Three maximum reports were recorded and among them best one was automatically selected by digital spirometer for print out. Predicted value, measured value and percentage of predicted value of FVC and FEV_1 of each experimental and control subjects were collected from print out. The data were expressed as mean ± SD. All the data were recorded systematically in a preformed master sheet and analyzed by computer using SPSS program version 14 for windows and significance tests were done by using ‘t’ test (independent sample ‘t’ test). In the interpretation of results, < 0.05 level of probability (P) was accepted as significance.

Results

Mean age was almost similar in both the groups but there were significant difference of height, weight and so, BMI between the groups.

Table I**:** Mean ± SD of age, height, weight and BMI of the subjects in group A and B

Variables	Group– A	Group– B	P
Age -yr	20.50± 1.48	20.47 ± 1.01	> 0.05 ^{NS}
Height-cm	160.91 ± 12.17	159.50 ± 5.15	<0.001 ***
Weight-Kg	77.26 ± 10.37	52.40 ± 6.25	< 0.001 ***
BMI-Kg/m^2	30.73± 5.92	20.33± 1.29	< 0.001 ***

There were significant differences of FVC and FEV_1 between the groups.

Table II: Mean ± SD of measured value of FVC and FEV_1 of the subjects in group A and B

Variables	Group -A	Group -B	P
FVC	2.59 ± 0.71	3.32 ± 0.31	< 0.001 ***
FEV_1	2.51 ± 0.71	3.17 ± 0.34	< 0.001 ***

There were significant differences of percentage of predicted value of FVC and FEV_1 between the groups.

Table III: Mean ± SD of percentage of predicted value of FVC and FEV_1 of the subjects in group A and B

Variables	Group - A	Group -B	P
FVC	64.43 ± 13.47	87.87 ± 6.64	< 0.01 **
FEV_1	72.93 ± 14.97	89.40 ± 8.10	< 0.01 **

87% subjects of group – A have some degree of restrictive lung function impairment (fig-1).

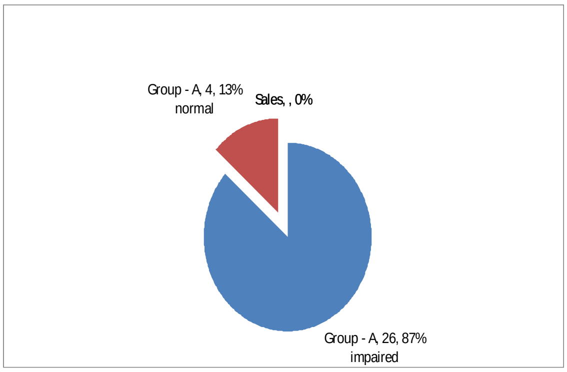

Figure 1. Degree of restricitve lung function impairment.

Group A: Experimental – apparently healthy non-smoker adult obese

Group B: Control – apparently healthy non-smoker adult non-obese

NS: Not significant

*****: Highly significant**

****: Moderately significant.**

Discussion

In this study, FVC and FEV_1 were assessed in apparently healthy non-smoker adult male and female obese and compared with those of age matched apparently healthy non-smoker adult non-obese normal weight control subjects of both sex.

Values of FVC and FEV_1 of control subjects were within normal limit. Obese had significantly lower measured and percentage of predicted value of FVC and FEV_1 than control subjects. Lung function impairment of experimental obese is mostly restrictive as they had mean percentage of predicted value of FVC is 64.43%. Similar findings were also reported by some researchers of other countries.[4, 10 - 15]

Various mechanisms have been proposed by different investigators for the impairment of lung functions of obese. It has been suggested that presence of adipose tissue around the rib cage, abdomen, subpleural space and in the visceral cavity loads the chest wall and decrease the downward movement of diaphragm and thus reduce expansion of chest and increase airway and parenchymal resistance.

Inn the present study it is difficult to comment on exact mechanisms of impaired pulmonary functions of obese. Obesity increase oxygen consumption and carbon dioxide production; it decreases the compliance of lung and chest wall and increase work of breathing. Mechanical effects of obesity increase airway resistance and decrease FEV_1. Obesity reduces the room for lung expansion and thus decreases TLC and FVC.

Conclusion

The results of this study conclude that obese have impaired pulmonary function and impairment is mostly restrictive. We should aware about obesity prevention and thus to reduce lung function impairment.

References

1. Choi JW, Pai SH and Kim SK. Association between total body fat and serum lipid concentration in obese human

adolescents. Annals Journal of clinical and laboratory science 2002; 32(3): 271 – 277.
2. Ramachandran A and Snehalatha C. Rising burden of obesity in Asia. Journal of obesity 2010; 2010 (2010):1 -9.
3. International Association for the study of Obesity (IASO). WHO, Western Pacific Region. The Asia - Pacific Perspective: Redefining obesity and its treatment. Obesity. 1st edn. Medical Department, Beximco Pharmaceuticals LTD. Dhaka, Bangladesh 2002; 17.
4. Salome CM, King GG and Berend N. Physiology of obesity and effects on lung function. Journal of Applied Physiology 2010; 108(1): 206 – 211.
5. Kabzic L. The Lung. In: Cotran RS, Kumar V and Collins T edn. Robbin's Pathologic Basis of Diseases. 6th edn. Philadelphia: WB Saunders Company 1999; 697 – 755.
6. Kumar and Clark. Respiratory Function Tests. In: Parveen Kumar and Michael Clark edn. Clinical Medicine. 6th edn. Philadelphia: Saunders Publishers 2005; 888 – 891.
7. Guyton AC and Hall JE. Respiration. In: Hall JE edn. The Text Book of Medical Physiology. 11th edn. Philadelphia: Saunders Publishers 2006; 471 – 533.
8. Asthma Association, Bangladesh. Spirometry. National Guidelines: A – B– C. 3rd edn. Dhaka 2005; 42 – 44.
9. Prof. A.B.M. Abdullah. Fibrosing Alveolitis. Short Cases in Clinical Medicine. 2nd ed. Published by Mrs. Mahmuda Begum, Dhaka, Bangladesh 2002; 178.
10. Supriyatno B, Sapriani I and Hadinegoro Sri RS. Pulmonary dysfunction in obese early adolescents. Med J Indones 2010: 19(3): 179 – 84.
11. Attaran D, Tohidi M, Asna-Ashari A-H, Ismaili H, Khadivi E and Gharaei S. Evaluation of the Correlation Between Body Mass Index and the Severity of Asthma in Recently Diagnosed Patients. Iranian Journal of Otorhinolaryngology 2011; 23(3): 93.
12. Srinivas CH, Madhavi Latha M, Sura Kumari N and Surendranath Y. Comparative Study of Dynamic Lung Function Tests in Obese and Non-obese Individuals. JEMDS 2013; 12(35): 6736 – 6742.
13. Simic V and Simic M. Obesity and Spirometric Restriction. Journal of Regional Section of Serbian Medical Association in Zajecar 2010; 35(1-2): 15 – 18.
14. Yeh F, Dixon AE, Marion S, Schaefer C, Zhang V, Best LG, Calhoun D, Rhoades ER and Lec ET. Obesity in Adults Is Associated With Reduced Lung Function in Metabolic Syndrome and Diabetes. Diabetes Journal 2011; 34(10): 2306 – 2313.
15. Saxena Y, Saxena V, Dvivedi J and Sharma RK. Evaluation of Dynamic Function Tests in Normal Obese Individuals. Indian J Physiol Pharmacol 2008; 52(4): 375 – 382.