Spirometric Measurements of Obese and Non-Obese Subjects in Recumbent Body Positions

Arvind Kumar Pal[1], Sunita Tiwari[2], Dileep Kumar Verma[3]

ABSTRACT

Introduction: Obesity results in progressive changes in lung function, causing a reduction in thoracic compliance, lung volumes and capacities. The aim of this study was to evaluate the influence of excess body weight on spirometry in three different recumbent body positions, evaluated by Body Mass Index.

Material and Methods: 107 sedentary volunteers were distributed into three groups, based on BMI. Spirometry was performed in three different body positions- horizontal dorsal decubitus (0 degree), crook lying and 45 degree Fowler's positions.

Results: The present study found that the FVC and FEV1 values were significantly lower in HDD compared with the crook lying and Fowler's positions in all three groups. The results also show that the spirometric values are slightly lower among obese comparing to overweight.

Conclusion: This study has shown a significant postural change in lung volume and flow rates for all three groups. Thus, it is important to evaluate those obese who remain bed restricted for long periods of time, trying to maintain them more upright body position.

Keywords: Obesity, Body mass index, Dynamic lung function, Spirometry

INTRODUCTION

Pulmonary function tests play a significant role in the assessment, diagnosis, quantification of the pulmonary ventilatory disorders, and treatment course.[1] Pulmonary function is known to change with age, gender, race, ethnicity and body mass index of the subject.[2] Spirometry is invaluable as a screening test of general respiratory health. Spirometry is more commonly performed in the sitting position until the subject is unable to do so. Different recumbent body position can also significantly change the spirometric values.

Obesity is a metabolic disorder characterized by an excessive accumulation of body fat. Obesity results in progressive changes in pulmonary function, causing a reduction in thoracic compliance, lung volumes and lung capacities, especially in functional residual capacity and expiratory reserve volume.[3-6] Total resistance of the respiratory system increases when obese patients change from the upright position to the supine position.[7] It is believed that obesity generates pulmonary restriction due to decreased diaphragmatic excursion by increased abdominal fat or weight on the chest wall, leading to a reduction in lung volume as compared to the values predicted.[8] However, there is still no definition about the behavior of the respiratory system of obese people in different body positions. Comparing obese and normal-weight subjects in the sitting and supine position, Yap et al.[7] observed in the sitting position, reduced forced vital capacity (FVC), forced expiratory volume in first second (FEV_1), total lung capacity (TLC) and functional residual capacity (FRC) in obese, while in the supine position, an increase in total respiratory resistance. Gudmundsson et al.[9] demonstrated that in obese individuals the FVC is greater in the supine compared to the sitting position while FEV_1 did not show any differences between the sitting and supine position.

Thus, knowledge of the physiological effects of different body positions on pulmonary function in obese individual is essential to guide the physical therapy procedures, including spirometry in clinical practice. The Aim of this study was to evaluate the influence of BMI on spirometry, in three different body positions 45^0 Fowler's position, crook lying and horizontal dorsal decubitus (0^0).

MATERIAL AND METHODS

A total of 107 university students (69 males and 38 females) from the King George's Medical University, Lucknow, aged between 18-35yr, BMI 18.5-28.8 kg/m^2 were selected for this cross-sectional study. Subjects having a history of smoking, any known cardio-respiratory disease or insufficiency, hemoptysis of unknown origin, any surgery/injury to the thorax or abdomen were excluded. The volunteers signed informed consent for participation in this study. The study was approved by the Research Ethics Committee of the University.

Subjects were divided into three groups according to body mass index (BMI), based on the South-East Asia classification. The groups showed the following characteristics: group 1 (normal weight) BMI = 18.5- 22.9 kg/m^2 (67 volunteers); group 2 (Overweight) BMI = 23 - 24.9 kg/m^2 (22 volunteers) ; group 3 (obese) BMI $\geq$ 25 kg/m^2 (18 volunteers). They were evaluated for FVC and FEV_1. Spirometric measurement was performed according to the American Thoracic Society/ European Respiratory Society guidelines[10] using PC-based spirometer (ndd medical technologies, Two Dundee Park,

[1]Senior Resident, Department of Physiology, [2]Professor, Department of Physiology, [3]Additional Professor, Department of Physiology, King George's Medical University, Lucknow, India

Corresponding author: Dr. Arvind Kumar Pal, Department of Physiology, King George's Medical University, Lucknow, India

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Study Subject (n)	107
Male (n%)	69(64.5%)
Female (n%)	38(35.5%)
Age (mean ± SD yr)	20.21±2.79
Height (mean ± SD cm)	167.08±10.13
Weight (mean ± SD kg)	62.46±9.98
BMI (mean ± SD kg/m^2)	22.27±2.61
Overweight (n%)	22(20%)
Mild to Moderate Obese (n%)	18(17%)

Table-1: Demographic data of subjects

Variables	BMI (kg/m^2)	No. Subjects	HDD (0^0) position	Crook lying position	45° Fowler's position	p-value[1]
FVC (L)	Normal weight (18.5-22.9)	67	2.97±0.64	3.10±0.64	3.20±0.66	0.001*
	Overweight (23-24.9)	22	3.31±0.82	3.50±0.86	3.63±0.88	0.001*
	Obese(≥25)	18	3.18±0.70	3.34±0.70	3.42±0.74	0.002*
FEV_1 (L)	Normal weight (18.5-22.9)	67	2.48±0.52	2.60±0.53	2.70±0.52	0.001*
	Overweight (23-24.9)	22	2.66±0.58	2.80±0.62	2.93±0.67	0.001*
	Obese(≥25)	18	2.59±0.50	2.77±0.51	2.86±0.53	0.007*

[1] ANOVA * Significant difference ($p < 0.05$) HDD- horizontal dorsal decubitus (0^0)

Table-2: Evaluation of FVC and FEV1 between different recumbent body positions in normal-weight, overweight and obese subjects

Andover, MA, USA). The three positions used in the present study were horizontal dorsal decubitus (0^0), crook lying, and 45^0 Fowler's positions. The sequence of positions was randomized by a random number table. Later, subjects were placed in selected body position and needed to perform a maximal inspiration to total lung capacity (TLC) followed by a maximal expiration. The spirometric value adopted in each position was the highest value among three measurements with the difference between the largest and the next largest FVC and FEV_1 of acceptance tests should be ≤ 200ml. All values obtained were corrected and expressed in BTPS conditions.

The Kolmogorov-Smirnov test evaluated all variables in this study regarding the normalcy of distribution. Mean and standard deviation was used to represent the spirometric data obtained in body positions analyzed. Repeated measures Analysis of Variance (ANOVA) with post hoc Bonferroni test was used to compare the mean values between each body position, considering significant whenever $p < 0.05$. All statistical analyses were performed using SPSS version 23.0.

RESULTS

Demographic features of subject from groups 1 to 3 are described in Table 1. The results of FVC and FEV_1 values obtained in the horizontal dorsal decubitus (0^0), crook lying, and 45^0 Fowler's positions for all groups are shown in Table 2. The present study found that the FVC and FEV_1 values were significantly lower in the horizontal dorsal decubitus (0^0) compared with the crook lying and Fowler's positions in all three groups. The analysis of the spirometric results, also shows that the values of FVC and FEV_1 it is slightly higher among overweight individual (BMI 23-24.9) comparing to normal weight and obese.

DISCUSSION

The present study found that the FVC and FEV_1 values were lower in the horizontal dorsal decubitus (0^0) compared with the crook lying and Fowler's positions in all three groups. Our study demonstrates that the obese individual, similar to normal weight, loses some 9% of their FVC and FEV_1 values when they adopt the lying posture. The finding confirms the results of Domingos-Benício et al.[11] which reported a statistically significant reduction in FVC, FEV_1, and FEV_1/FVC ratio in dorsal decubitus in relation to the sitting position. This may be occurring due to decreased dynamic lung compliance and increased airway resistance caused by increase intrapulmonary blood flow in this position.[12,13] In horizontal dorsal decubitus (0^0), the reduction of pharyngeal diameter occurs, which increases the upper airway resistance. The cephalic displacement of the diaphragm due to increased abdominal pressure results in reduced lung volume at rest in this position.[13] In HDD position, anterio- posterior diameter of the chest wall is also limited.

This study also evaluates the pulmonary function, through spirometry, of obese people, in different degrees of obesity. When comparing the values of FVC and FEV_1 it shows highest value among overweight (BMI 23-24.9) compared to normal-weight and obese subjects. It is may be due to them have longterm obesity and developed adaptive mechanisms against the overload imposed by adipose tissue and, therefore, do not present significant reductions in spirometric values. Our results are in agreement with Ladosky et al.[14] when comparing normal weight and obese patients reported reduction in FVC and FEV_1 proportional to the increment in BMI. Lazarus et al.[15] reported an inverse relationship between FVC and BMI; a direct relationship between FEV_1/ FVC and BMI; and found no correlation between FEV_1 and BMI. In contrast, Sarikaya et al.[4], who compared spirometries with non-obese patients and grades I, II, and III obese patients in the sitting position, higher values in the group of grade III obesity (BMI >40 kg/m^2; 86%) were observed, with mean

FVC of 108.26%. Rubinstein et al.[16] claim that there is a correlation between BMI and lung function, except for the FEV_1 / FVC. Gilbert et al.[17] and Kelly et al.[18], also showed that there were no changes in FVC, FEV_1, FEV_1/FVC and FEF2575% when studying obese individuals.

The present study demonstrated that, the body position has an effect on various spirometric parameters in all subjects. It reveals an important connection between posture and pulmonary function that could increase the quality of life in many individuals. This has practical implications, note that obese patients have difficulties in maintaining the semi-sitting position in the postoperative period. Even at 45^0 inclinations, very often they slide into the bed, resulting in a lower inclination, which potentially hinders their respiratory pattern. Thus, it is important to evaluate obese patients in the immediate postoperative period, trying to maintain them more elevated than 45^0.

CONCLUSION

This study has shown a significant postural change in lung volume and flow rates for both normal individuals as well as obese individuals. The results suggest that there is difference between FVC and FEV_1 in normal weight and obese individuals and that there is a reduction in FVC and FEV_1 in the supine position for both normal individuals and for obese individuals. This has serious clinical implications needing special attention for those obese who remain bed restricted for long periods of time.

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