Original Article

Impact of overweight and obesity on ventilatory function among male medical students

Rajab Ali Khawaja[1], Shahabuddin Turabuddin Shaikh[2], Muhammad Munir Sharif[3]

ABSTRACT

Objectives: To correlate the respiratory function among normal weight (BMI > 18.5 – 24.9 Kg/m²), overweight (BMI > 25 – 29.9 Kg/m²) and obese (BMI > 30 Kg/m²) male medical students who did not have evidence of obstructive or restrictive airway disease or other underlying diseases affecting their respiratory system. The other objective was to assess the correlation of respiratory function & body mass index (BMI).

Methodology: Cross sectional controlled study was conducted among 113 eligible male medical students at college of medicine, King Saud University Riyadh, Kingdom of Saudi Arabia during August 2009 – July 2010. Body mass index was used to assess the obesity and forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) were used to assess respiratory function. One way ANOVA was used to find the difference between BMI groups and bivariate correlation analysis was done to find out the strength of the relationship among BMI and respiratory function parameters.

Results: FEV1, FVC and FEV1/FVC ratio were linearly and mildly inversely related with BMI in overweight (r = -0.338, -0.291, -0.311 respectively) and obese (r = -0.375, -0.349, -0.040 respectively). In normal weight subjects, FEV1 and FVC were mildly positively correlated (r = 0.136 and 0.219 respectively) and FEV1/FVC ratio was negatively correlated (r = -0.166) with BMI.

Conclusion: Overweight and obesity are associated with pulmonary dysfunction among young male population.

KEY WORDS: Respiratory function, Ventilatory function, Obesity, Overweight, Medical students.

Pak J Med Sci April - June 2011 (Part-II) Vol. 27 No. 3 505-509

How to cite this article:

Khawaja RA, Shaikh ST, Sharif MM. Impact of overweight and obesity on ventilatory function among male medical students. Pak J Med Sci 2011;27(3):505-509

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* Received for Puublication: January 13, 2011
* Revision Received: January 21, 2011
* Revision Accepted: April 21, 2011

INTRODUCTION

In today's era of health conscious society and increasingly educated population, the health, lifestyle and behavior of a doctor has become significant.[1] Overweight and obesity is today's highly visible – yet neglected public health problem and is known to have negative bio-psycho-social effect and affects various organ systems in the body including lungs.[2-4]

Negative impact of obesity on respiratory function through several mechanisms has been shown by various studies. The most common abnormalities reported are decreased expiratory reserve volume and functional residual capacity due to reduced chest wall and lung compliance and increased respiratory resistance.[5-6] It is also believed that increased pulmonary blood volume leads to congestion resulting in thickening of the airway wall; thus reducing airway size[7]

Many studies find that lung function, as described by the forced expiratory volume in one second (FEV1) and/or forced vital capacity (FVC), is inversely correlated with general, pulmonary, and cardiovascular mortality and morbidity.[5]

Medical students of today are the health caretaker of the society tomorrow. Their own health status would significantly affect their influence on the society. Today's overweight and obese youth expect prevention counseling during their visit to physician[8], so medical students of today should take care of their own health and be bio-psycho-socially healthy before their practical life as a health care provider.

The aim of our study was twofold: (1) to determine the predominant pulmonary function abnormality in male medical students who are otherwise healthy and free from serious or chronic diseases; and (2) To assess the correlation between the severity of lung function impairment and the degree of obesity.

METHODOLOGY

This Cross sectional study was conducted at King Khalid University hospital & College of Medicine, King Saud University Riyadh, Kingdom of Saudi Arabia. We enrolled 150 male Medical Students of 19-22 years age, studying at College of Medicine during the study period (August 2009 – July 2010).

Exclusion criteria: During the consultation, participants were excluded if having signs and/or symptoms of obstructive or restrictive airway disease. Out of 150 enrolled male medical students, 37 did not fulfil the study criteria and were excluded from the study.

Pulmonary function: One hundred and thirteen students completed the study criteria and were reffered for pulmonary function test. Forced vital capacity (FVC) & forced expiratory volume in one second (FEV1) and ratio of FEV1/FVC were used as a pulmonary function test. The evaluation of pulmonary function test was performed by using "Vitalograph Gold STD Model No. 2150" (by Vitalograph [Ireland] limited, Ennis, Co Clare, Republic of Ireland) after calibration at 3 liters and temperature calibration at room temperature.

After instruction, each subject performed a minimum of two forced expiratory maneuvers to provide estimates of forced vital capacity (FVC) and FEV1. Forced vital capacity is the maximum volume of air expired during forced expiration and is primarily an indicator of lung volume. FEV1 is the volume of air expired in the first second of forced expiration and is influenced by lung volume and airflow obstruction. Tests were carried out standing and without nose clips. The higher values of the two readings for FEV1 and FVC were used for analysis. We defined a ratio of FEV1 to FVC (an indicator of airflow obstruction) of < 70% as low. Possible chronic obstructive pulmonary disease (COPD) was defined on the basis of an FEV1: FVC of < 70%.

Body mass index (BMI): Body mass index is an index of weight-for-height that is commonly used in classifying overweight and obesity in adult populations. One of the investigators (General Physician) took the anthropometric measurements of participants while they stood in light clothing without shoes, using a standard protocol. Height was measured to the nearest 0.1 cm using a free-standing stadiometer. Weight was measured to the nearest 100 gram using digital scales. We used World Health Organization (WHO) classification reference for obesity in this study.[9] According to WHO, Under-weight = BMI < 18.5 Kg/m^2; Healthy weight = BMI > 18.5 to < 25 Kg/m^2; Over-weight = BMI > 25 to < 30 Kg/m^2; Obesity = BMI > 30 Kg/m^2.

Statistical analysis: SPSS-16.0 statistical software was used for all the analysis. One way ANOVA was used to find the difference between BMI groups and bivariate correlation analysis was done to find out the strength of the relationship between BMI and FEV1, FVC and FEV1/FVC ratio. If $p < 0.05$, it was considered to be significant.

Ethics: Approval of the hospital ethic committee was obtained for the study. Informed consent from the participants was obtained.

RESULTS

Of the 150 students, 37 (24.66%) were excluded due to under-weight (8), smoking (6), history of bronchial asthma (4), diabetes (3), history of intense athletic activity (12) and family history of cardiopulmonary disease (4).

After exclusion, 113 male medical students of 19-22 years old (mean age 19.8 ± 0.72) formed the basis of this analysis. Of the study population, 68 (60.2%) were of normal weight (BMI > 18.5 – 24.9 Kg/m^2), 19 (16.8%) were overweight (BMI > 25 – 29.9 Kg/m^2) and 26 (23%) were obese (BMI > 30 Kg/m^2). There was no significant difference in age of BMI category groups ($p = 0.212$). Mean age, height, weight and PFT testing variables are shown in Table-I.

Table-I: Age, anthropometric measurement and PFT parameters (n = 113).

Variables	*Min.*	*Max.*	*Mean ± SD*
AGE (years)	19.00	22.00	19.80 ± .72
Height (meters)	1.54	1.88	1.73 ± 0.06
Weight (kg)	51.00	156.00	77.01 ± 20.39
BMI (Kg/m^2)	18.50	45.71	25.74 ± 6.64
FEV1 (L)	1.50	5.70	4.09 ± 0.62
FVC (L)	2.20	6.40	4.65 ± 0.65
FEV1/FVC %	68.18	100.00	87.92 ± 5.90

PFT = pulmonary function test; BMI = body mass index; FEV1 = forced expiratory volume in 1 second; FVC = forced vital capacity; FEV1/FVC% = ratio of FEV1 to FVC.

One way ANOVA test was applied to compare the different variables among BMI category. Mean age, FEV1 and FVC were not significantly different among different BMI categories. Only mean FEV1/FVC ratio among BMI category was highly significant ($p< 0.005$) (Table-II).

Correlation of BMI with pulmonary function was mild to moderately modify by BMI category. The correlation of BMI with FEV1, FVC and FEV1/FVC ratio was negative among overweight and obese subjects. However, BMI was positively associated with FVC and FEV1, whereas negatively associated with FEV1/FVC ratio (Table-III).

The overall effect of BMI on FEV1, FVC and FEV1/FVC ratio was also analyzed by correlation coefficient. BMI showed weak and non significant positive association with FEV1 ($r = 0.116$; $p = 0.220$) and FVC ($r = 0.033$; $p = 0.727$), whereas moderately positive and highly significant association for FEV1/FVC ratio ($r = 0.322$; $p = 0.00$) (Fig 1a-1c).

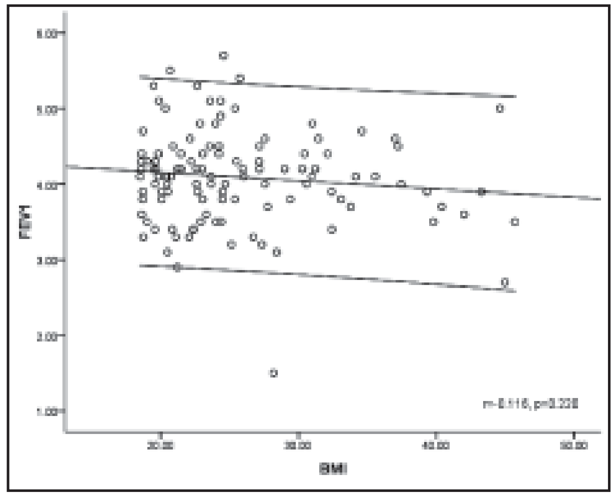

Fig-1A: Scatter plot showing linear relationship between BMI (body mass index) and FEV1 (forced expiratory volume in 1 second) in 113 male medical students having no restrictive or obstructive lung disease.

DISCUSSION

In our data, overweight and obese compared to non obese subjects did not differ in mean FEV1 or FVC. FVC as determined by spirometry reflects total compliance, which has contributions from both the lung and chest wall. The FEV1 reflects these same factors plus airway resistance.

An important observation of this study is a negative association between BMI and pulmonary function among overweight and obese; whereas, correlation of BMI and pulmonary function is positive

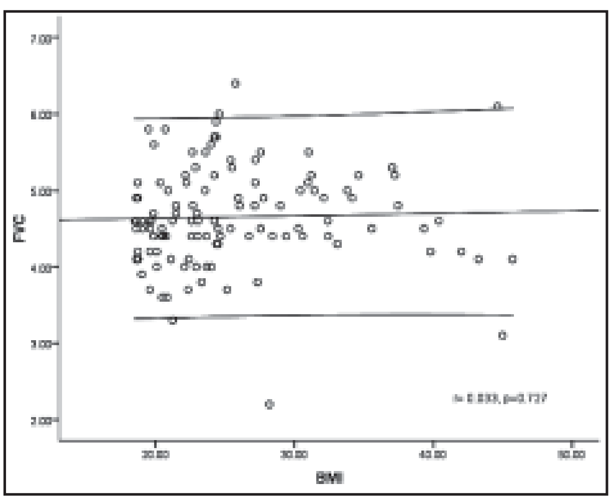

Fig-1B: Scatter plot showing linear relationship between BMI (body mass index) and FVC (forced vital capacity) in 113 male medical students having no restrictive or obstructive lung disease.

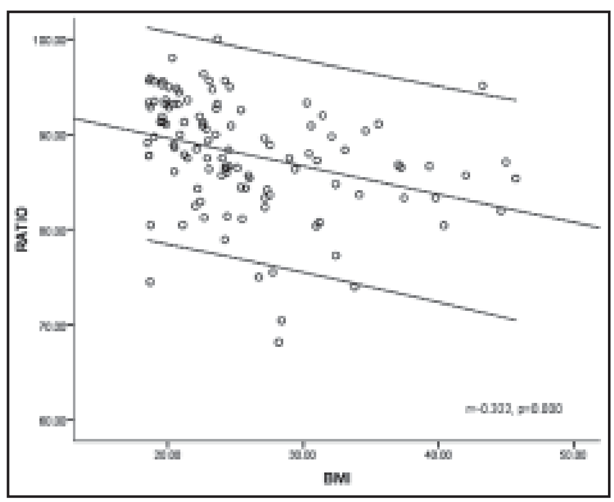

Fig-1C: Scatter plot showing linear relationship between BMI (body mass index) and ratio (ratio of FEV1 to FVC) male medical students having no restrictive or obstructive lung disease.

Table-II: Age and PFT parameters in subgroups.

Variable	*Non-obese (n=68)*	*Overweight (n= 19)*	*Obese (n=26)*	*P value*
AGE (years)	19.78 ± 0.75	19.63 ± 0.60	20.00 ± 0.69	0.212
FEV1 (L)	4.16 ± 0.59	3.91 ± 0.84	4.05 ± 0.51	0.306
FVC (L)	4.62 ± 0.62	4.69 ± 0.87	4.72 ± 0.58	0.758
FEV1/FVC %	90.09 ± 4.96	82.90 ± 6.38	85.94 ± 4.97	0.000

PFT = pulmonary function test; FEV1 = forced expiratory volume in 1 second;
FVC = forced vital capacity; FEV1/FVC% = ratio of FEV1 to FVC.

among normal weight subjects. These findings suggest that obesity has a primary effect on lung volume. However, linear trend between BMI and FVC, FEV1 and FEV1/FVC ratio is mildly to moderately positive. This positive trend could be due to the higher proportion of normal subjects in this study. Another interesting observation is the linear trend of BMI, which is more positively correlated with FEV1 than FVC, leading to a significant decrease of FEV1/FVC ratio. Significant decrease in FEV1/FVC ratio in relation to increasing BMI is alarming and is a sign of obstructive lung disease.

These results are consistent with several previous epidemiologic studies. In a cross sectional study of 1674 adults aged above 18 years found negative association between BMI and pulmonary function among overweight and obese, while BMI was positively associated with FVC and FEV1 in normal-weight subjects.[10] Similar findings were observed among Indian male and females of 20 – 40 years of age.[11] Sekhri V et al, in a recent study of 433 morbidly obese patients found a significant impact of increased BMI on the forced vital capacity (FVC), forced expiratory volume (FEV1), expiratory reserve volume (ERV), residual volume (RV), total lung capacity (TLC) and partial pressure of oxygen in arterial blood (PaO2).[12]

BMI is calculated from body weight and height, which is correlated with body size. Compared with Waist Hip Ratio (WHR) or Waist Circumference (WC), BMI is a more convenient measure, is less likely to be influenced by sex or degree of obesity and can easily be applied in large-scale epidemiologic studies. However, it does not reflect visceral adiposity in a better way or separate out contributions of increased abdominal mass. Hence, several studies used waist hip ratio (WHR) or waist circumference (WC) as an indicator of obesity and assessed the impact on pulmonary function. Canoy et al, compared the relations of WC, WHR, and BMI with FVC and FEV1 and found that pulmonary function was negatively associated with increasing quintiles of WHR, WC, and BMI.[12] After adjustment for BMI, sub scapular skinfold thickness was also negatively associated with both FVC and FEV1 ($p <$ or $= 0.02$).[13] In an Australian study of the effects of body composition and fat distribution on ventilatory function, Lazarus et al. investigated a single measurement, FVC only, and found significant negative association with waist circumference in men but not in women.[14]

In a fourth Scottish MONICA cross-sectional survey of 865 men and 971 women aged 25-64 years, author found inverse association of obesity (defined by waist circumference criteria) with FVC (men: 8 mL/cm; women: 7 mL/cm) and FEV1 (men: 17 mL/cm; women: 9 mL/cm).[15] In the EPIC-Norfolk cohort study, UK analyzed 9674 men and 11 876 women aged 45-79 years with no preexisting serious illness,

Table-III: Correlation of BMI with PFT variables by BMI category.

Variable pair correlation		*P value*	*R*
Normal weightn=68 (60.2%)	BMI Vs FEV1	0.27	0.136
	BMI Vs FVC	0.073	0.219
	BMI Vs FVC/FEV1 ratio	0.176	-0.166
Overweightn=19 (16.8%)	BMI Vs FEV1	0.156	-0.338
	BMI Vs FVC	0.227	-0.291
	BMI Vs FVC/FEV1 ratio	0.195	-0.311
Obesen=26 (23.0%)	BMI Vs FEV1	0.059	-0.375
	BMI Vs FVC	0.080	-0.349
	BMI Vs FVC/FEV1 ratio	0.845	-0.040

PFT = pulmonary function test; BMI = body mass index; FEV1 = forced expiratory volume in 1 second;
FVC = forced vital capacity; FEV1/FVC% = ratio of FEV1 to FVC.

found significant relations of abdominal obesity with FVC and FEV1 in both men and women.[12]

In one study, author suggests that WC is better indicator of obesity than BMI in elderly people.[16] In a descriptive analysis by Burrows B et al, increasing age was related to a decline in FEV1 and FVC.[17] In the CARDUA study, participants with baseline BMI e" 26.4 Kg/m² also experienced 10 year decreases of 185 ml in FVC and 64 ml in FEV1.[18] In another study, total body fat and central adiposity were inversely associated with lung function in elderly.[19]

The present study has several strengths, including narrow age range at entry and high quality of data collection through strict quality control across examinations. Limitations of the study were related to recruitment. We examined only male aging 19-22 years; hence we did not recruited female, children or elderly population. Another limitation was related with definition of obesity. We used BMI to classify obesity as per international classification and did not look at the distribution of body fat (by WC or WHR).

CONCLUSION

Our study found an inverse relation between BMI and pulmonary function among overweight and obese male medical students who had no previously known any serious or chronic disease. The clinical importance of the magnitude of association between BMI and pulmonary function observed in the current study is not clear. However, numerous studies documented that over-weight and obesity is associated with chronic respiratory disease among all age groups and both sexes.

ACKNOWLEDGEMENT

The author would like to thank the medical students at the college of medicine for their participation in the study.

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