The Impact of Obesity on Pulmonary Functions Among Healthy Non-Smoking Adult Females

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Abstract—

Background: Obesity has increasingly become a cause for various chronic disorders such as cardiac problems, hepatobiliary diseases, and some cancers. Furthermore, obesity has an impact on respiratory systems which worsening lung functions and developing of respiratory symptoms.

Objective: To identify the impact of obesity on the pulmonary functions among healthy non-smoking adult females.

Methods: A case-control study was conducted among young healthy adult females between 18 to 25 years old at King Faisal University in Al Ahsa, Saudi Arabia. The subjects categorized into two groups regarding their BMI. The first group consisted of obese subjects with BMI of 30 kg/m2 and above while the other group consisted of non-obese subjects with BMI of 18 to 29.9 kg/m2. Values of the forced expiratory volume in one second (FEV1), forced vital capacity (FVC) and peak expiratory flow rate was measured by spirometry.

Results: No significant differences were found in the ratio of forced expiratory volume in the first second to the forced vital capacity of the lungs (FEV1/FVC) and peak expiratory flow rate between the obese group and the non-obese group (statistically insignificant with p-value >.05). However, a significant negative correlation found between BMI and FVC (p-value <.05), FEV1 (p- value <.05). Further, no correlation found between BMI and FEV1% (p-value > .05).

Conclusion: There is a reduction in pulmonary function values among obese participants which indicate that obesity considers as a risk factor which may lead to restrictive lung disorders. These findings emphasize on the importance of taking the appropriate measures to prevent obesity which reduces risks for possible future respiratory problems.

Index Terms— Body Mass Index, BMI, Obesity, Spirometry, pulmonary function tests.

INTRODUCTION

Obesity has increasingly become a major public health issue in many parts of the world which associated with various health conditions. (*DeNicola E et al., 2015*) Obesity prevalence has been increasing over several decades with a rough estimation of over 1.6 billion being overweight adults worldwide (BMI >25 kg/m2). (*Ogden CL et al., 2004*)

Obesity is defined medically as a chronic condition of accumulation of the excessive amount of fat on the human body which leads to increase in the body mass. Body mass index (BMI) is the measure which reflects the severity of the condition by calculating the weight in kilograms divided by the square of the height in meters (BMI = weight (kg)/ height (m2)). (World Health Organization, 2016). Further, WHO defined Obesity in adults whenever the BMI is above or equal to 30 kg/m2, whereas the normal range of BMI is between 18.5 and 24.99 kg/m2. (*El–Gamal, et.al ,2005*).

Currently, Saudi Arabia becomes one of the highest countries in the prevalence rate of obesity and overweight. (*De Nicola E, et al., 2015*). Obesity in Saudi Arabia becomes a serious health issue concern as 7 out of 10 people are suffering from this problem. (*Memish ZA, et al. 2014*). Various factors play a role to make people prone to be obese, such as genetic predisposition, environmental and behavioral factors. Further, sedentary lifestyle such physical inactivity and increasing calorie intake. (*Yogesh Saxena, et al 2008*). Studies evidence that obesity links with various health conditions such coronary artery diseases, diabetes, hypertension and pulmonary problems. (*Afaf A S et al., 2011*). Memish et al. (2014) conducted a study in Saudi Arabia at a national level and reported the prevalence rate of obesity amongst Men which is 24.1% that associated with hypertension, diabetes, and hypercholesterolemia whereas it is 33.5% amongst women that associated with hypertension as well, and history of other chronic diseases.

Respiratory problems increased amongst obese people such shortness of breath which becomes apparent while exercising

even when there is no history of pulmonary diseases and worsened with the increasing of the BMI. (*Sahebjami,1998*); (*Jones& Nzekwu,2006*). Further, Obesity leads to various detrimental effects on respiratory functions as it decreases respiratory muscle strength and changes in mechanics of respiration. (*Koeing SM,2001*); (*D Costa et al ,2008*).

Since the obesity is associated with deleterious effects on respiratory systems, it becomes necessary to evaluate the impact of obesity on respiratory function test among healthy non-smoking adult females in Saudi Arabia. Therefore, the present study was designed to evaluate the impact of obesity on pulmonary functions among young adult females.

SUBJECTS AND METHODS

2.1 Study design

This case-control study was conducted in the physiology laboratory, college of medicine at King Faisal University, Al Ahsa, Saudi Arabia during the academic year of 2013-2014 amongst Saudi female medical students.

2.2 Participants' characteristics

Our sample recruited 60 non-smoking healthy adult females aged between 18-26 years old. The study subjects were briefed about rational of the study and prior to the commencement a verbal informed consent was obtained from each participant. Investigators elicited a brief history from participants to confirm there is no history of pregnancy, pulmonary, cardiac and psychiatric or any other diseases as we need healthy subjects to exclude presence of confounding factors that may interfere with the outcomes of our study.

2.3 Study protocol

We divided the subjects into two equal groups according to their BMI. Body mass index (BMI) is an indirect measure of a person's body fat, calculates for each subject according to the formula adopted internationally: BMI = weight (kg)/height (m)2. BMI is calculated as the weight in kilograms divided by the square of the height in meters. The first group consisted of 30 non-obese subjects with BMI of 18 to 29.9 kg/m2 (control group) and the second group consisted of 30 obese subjects with BMI of 30 kg/m2 and above (study group).

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2.4 Tools to assess Pulmonary Functions

- The subjects who volunteered to contribute in our study underwent clinical assessment of pulmonary function tests by spirometry as it a device that commonly used as a screening tool which provides a reliable reflection of how does the long functioning by measuring lung volumes and capacities to provide presence of abnormalities easily. The subjects were made familiar with using spirometry as they instructed to take the biggest possible breath and blow out as hard and long as she could in the mouthpiece of the spirometer. The machine measures how much air she can blow out from her lungs and how fast she can blow it out. In our study with this technique the spirometry tests measured were the forced vital capacity (FVC), peak expiratory flow rate (PEFR) and forced expiratory volume in one second (FEV1).

2.5 statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences, SPSS Inc., Chicago, IL (SPSS version 20.0). Descriptive statistics were applied to calculate number of total study sample for both groups using p values between both groups. p value less than 5% was considered statistically significant for all tests. Moreover, A Chi- square test was done to investigate presence of a significant correlation between BMI and pulmonary function tests; A P- Value of < 0.05 was considered significant.

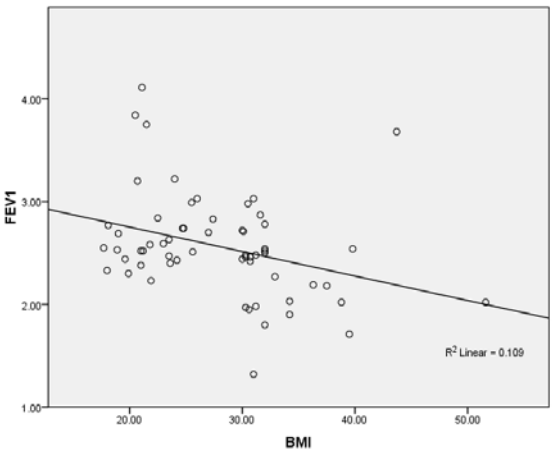
RESULTS

Our study recruited 60 females and the data obtained from 30 non-obese (considered as control group) and 30 obese subjects (non-controlled group) were statistically analyzed. Initially, the mean and standard deviations of the anthropometric parameters were calculated. The t-test (p value) was used to test the statistical significance of the difference for FVC, FEV1, % FEV1, PEFR between the non-obese and the obese groups. When all of the parameters were compared between the two groups as it has shown **in (Table 1**), with no significant differences were observed in age for both group (p>0.05) which p=.247. However, the obese group (OG) showed a higher BMI, as expected (p< .05). Concerning spirometric variables there is significant difference in OG which clear from the table OG with high BMI they have reduced in pulmonary function with FVC, FEV1, PEFR whereas BMI with FEV1% result has shown that no significant differences were observed.

Further, *In figure (1),* A strong negative correlation between BMI and FVC**.** As BMI increase in value, the second variable FVC decreases in value. From the table (*pearson correlation sig. (2-tailed)* is .015) which indicates presence of significant statistical correlation between the two variables. When one increases the other will decrease.

In figure (2), there is a strong negative correlation between BMI and FEV1**,** when BMI increases, the second variable FEV1 decreases in its value *(p value is 0.010) which indicates presence of*

significant correlations between the two variables. When one increases the other will decrease. *whereas figure (3),* showed presence of weak negative correlation between BMI and (FEV1%) values. Further, there is no statistically significant correlation between the two variables as (*p* value is 0.830). Therefore, increases or decreases in BMI does not significantly related to increases or decreases in FEV1%. *In figure (4),* a strong negative correlation has been shown between (BMI) and (PEFR) with statistical significance of (*p value*< 0.011) observed when both groups were evaluated.



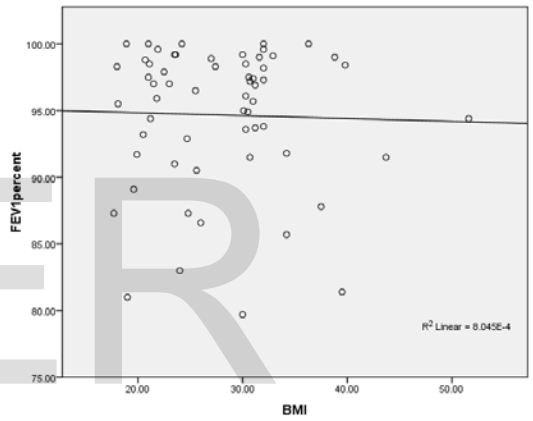
[Figure2]Correlation between (BMI) & (FEV1)

Table 1. Shows mean age, weight, height, BMI, (spirometry variables):

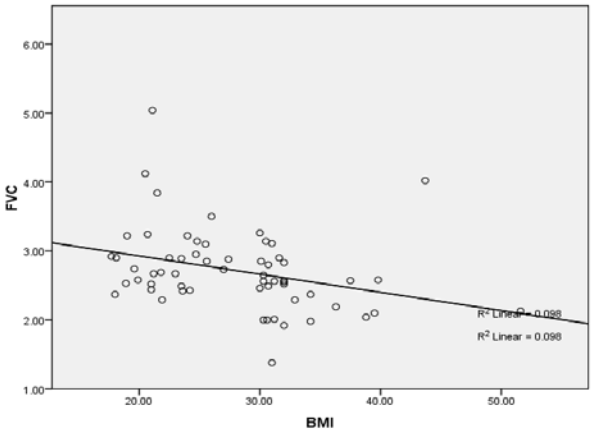
FVC, FEV1, %FEV1 (non-obese and obese groups) and PEFR.

Variables	OBESE GROUP (n=30)	NON-OBESE GROUP (n=30)	*p*	t
AGE (years)	20.80±2.31	21.50±2.33	.25 *ns*	1.17
Height (cm)	156.53±7.152	157.43 ± 4.97	.57 *ns*	.57
Weight (kg)	82.90±17.795	55.50 ±8.09	.00	-7.68-
BMI (kg/m²)	33.60±4.91	22.24±2.70	.00	-11.11-
FVC (L)	2.49±.507	2.94±.579	.002	3.19
FEV_1 (L)	2.37±.47	2.76±.46	.002	3.32
FEV_1/FVC	94.79±5.24	94.54 ±5.36	.850 *ns*	-.19-
PEFR (L)	4.82±1.29	5.74±1.38	.011	2.64

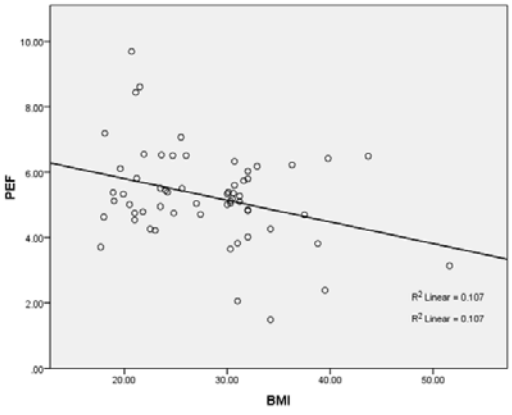
$\bar{x}$ ± SD (mean±standard deviation); *n* =60 (n=30 obese, n=30 non-obese); BMI: Body mass index; FVC: forced vital capacity; FEV_1: forced expiratory volume in one second; PEFR :peak expiratory flow rate; *ns*: not significant.



[Figure3]Correlation between (BMI) and (FEV1%).



[Figure1]. Correlation between (BMI) & (FVC).



[Figure4]Correlation between (BMI) and (PEFR).

DISCUSSION

The present study was an effort to investigate the pulmonary function values among obese young adult females in comparison with non-obese females.

Analysis of the collected data has exhibited presence of correlation between obesity and pulmonary functions as there was a reduction in pulmonary function values amongst obese subjects whom their BMI was equal or more than 30kg/m². A declined pulmonary function noted for forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) values among obese subjects. Our results are similar to a study conducted by (Joshi et al., 2008) which reported the presence of negative correlation with forced vital capacity (FVC), maximum ventilatory volume (MVV) and forced expiratory volume at the end of first second (FEV1) by increasing body mass.

The decline in various lung function parameters in obesity has been described by scientists through different mechanisms. A theory suggested that expansion of diaphragm may be mechanically affected by the excessive amount of fat that deposits between the muscles and ribs which increase the workload of breathing in the obese group because of reducing chest wall compliance. (*Shashi, 2012*).

Recent studies stated that besides increasing body mass results in the reduction of lung volumes among obese people, the nature of body fat distribution is contributed as a further factor for deteriorating as well. Abdominal adiposity contributes to intense impairment of lung parameters in comparison of peripheral distribution of fat. (*Ochs-Balcom et al., 2006*); (*Ladosky, et al,2001*).

No significant difference was observed in value of FEV1/FVC ratio as both values are declined to the same extent among obese group but when compared to the control group; it was found to be reduced which indicates that obesity influences pulmonary values without causing airway obstruction. Such findings imply presence of restrictive lung pattern rather than obstructive lung pattern. (*Salome CM et al, 2010*)

Further, results of our study found a negative correlation between obesity and PEFR. Few studies reported similar findings (*Koenig,2001); (Kalpana,2011); (del Rio, et Al, 2000*) that with increasing body mass; there is a reduction in PEFR.

CONCLUSION

Our study concludes that obesity has a harmful effect on the mechanism of respiration. Changes in pulmonary functions such as reduction in the FVC, FEV1, and PEFR is found with increasing BMI without a compromise in other respiratory volumes. This indicates that obesity is considers as a risk factor for deteriorating lung functions in the adult female. Such outcomes in a concordance with a high prevalence of obesity in Saudi Arabia will increase the strain on government's resources and individuals as results of serious obesity burden and its sequelae. Therefore, there is an urgent need to identify and tackle this problem at an early stage by raising obesity as a serious health issue at the national level and set strategies to combat and prevent negative effects of obesity on health and quality of life through awareness programs, social media and healthcare providers to avoid possible future health problems.

ACKNOWLEDGMENT

We would like to thank Professor Dr Amani El Amin for her assistance and guidance to conduct this research and all participants that made this study is possible.

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