ISSN: 1343-4292
Volume 140, Issue 01, April, 2022

The impact of Body Mass Index on Spirometric Parameters among a Sample of Population

Dina Ruby[1*]

Lecture of chest disease faculty of medicine Ain Shams University, Cairo, Egypt[1]

Corresponding author: 1*

ABSTRACT— Obesity represents one of the major health problems of modern life and directly affects respiratory mechanics. So the objective of this study is to detect the impact of body mass index (BMI) on spirometric parameters among a sample of the adult population in Egypt and to detect which of the spirometric parameters is majorly affected. We retrospectively included 80 participants > 18 years old with normal pulmonary function (forced expiratory volume in 1 second (FEV^1) and forced vital capacity (FVC) > 80% and forced expiratory volume in 1 second/forced vital capacity (FEV^1/FVC)> 70% of predicted) visiting Ain Shams University hospital, between March 2019 and October 2019 then they were divided into 3 groups according to the BMI. Statistical significant decrease in FVC, FEV^1, FEV^1/FVC %, and FEF 25 - 75 % were found as BMI increases and there was a negative correlation between BMI and spirometric parameters.

KEYWORDS: body mass index, obesity, pulmonary function, spirometric parameters.

1. INTRODUCTION

Obesity is considered one of the critical topics that affects health all over the world, [1] as it is associated with diabetes, and hypertension [2], and it is assessed by body mass index (BMI) BMI is measured by dividing individuals, weight (in kg) by the square of height (in m) [3]. Weight categories associated with increased morbidity can be screened by BMI [4]. Egypt occupies the 18th rank with the highest prevalence of obesity all over the world according to the World Health Organization [5].

The respiratory symptoms are higher among obese people and they suffer from shortness of breath, especially during exercise, even though they have no respiratory illness [6], [7]. The pulmonary function test is one of the essential tools for the assessment of pulmonary function [8]. To explore the impact of obesity on respiratory function, many investigators discussed this topic as [9] who work on the data from 373 patients and found that BMI had negatively affected all lung volumes, mainly functional expiratory reserve volume, and residual capacity.

Although the impact of obesity on spirometric parameters has been mentioned in many previous works of literature, controversies are still present in terms of which spirometric parameters are affected [10], [11]. Thus this study aimed to detect the impact of BMI on spirometric parameters among a sample of adult population in Egypt and to detect which of the spirometric parameters are majorly affected.

2. Methods

This retrospective study was carried out by convenience sample on 80 adult participants who were attending the unit of pulmonary function in Ain Shams University hospital, chest department in the duration from March 2019 to October 2019 and we collected the data of the participants from the records on the

spirometry device (Viasys Health Care spirometer D-97204, Hochberg, Germany) which was calibrated daily and carried out by respiratory therapists and nurse, according to ATS guidelines [12].

The data collected include age, gender, weight, height, BMI, spirometric parameters ((FEV1/FVC%, FEV1, FVC, and FEF25-75%).The inclusion criteria were adult participants above 18 years old with normal spirometric parameters (FEV1/FVC % > 0.7, FEV1> 80%, FVC > 80%, FEF25-75 >65) [13].

The participants were then divided according to their BMI into three groups as the following: a) first group (normal weight): participants with BMI between 18.5kg/m^2-24.9 kg/m^2, b) second group(Overweight): participants with BMI between 25kg/m^2-29.9 kg/m^2 c) third group(Obese): participants with BMI ≥ 30 kg/m^2.

2.1 Statistical analysis

Data was collected and analyzed by SPSS (statistical package for social science) version 25. Qualitative data were in the form of number and percentage, quantitative data were in the form of mean ± SD. ANOVA (f) test compared three or more groups with quantitative variables, correlation test was carried out by Pearson's correlation in case of parametric quantitative data or Spearman's in case of non-parametric quantitative and qualitative data. The p-value will be statistically significant if less than 0.005 & high significant if less than<0.001.

3. Results

Our retrospective study was carried upon 80 adult male participants as there was no female during the duration of our study and they were classified into 3 groups (normal weight group=20 participants, overweight group=30 participants and obese group =30, table (1) showed the mean age of the normal group was 66.97±4.42 years old; the overweight group was 64.31±7.75 years old and the obese group was 64.71±5.58 years old. No statistically significant difference was detected between the normal weight, the overweight and obese groups as regards age and height. But the statistical significant increase was found in weight and BMI in overweight and obese than normal-weight group.

Table (1): Anthropometric data of participants:

	Groups			**ANOVA test**	
	Normal weight group (n = 20)	**Overweight group (n = 30)**	**Obese group (n = 30)**	**F**	**P-value**
Age(years)	66.97 ± 4.42	64.31 ± 7.75	64.71 ± 5.58	1.679	0.193
Height(cm)	164.25 ± 8.11	166.53 ± 6.17	162.57 ± 5.02	2.300	0.107
Weight(kg)	58.56 ± 10.07	75.94 ± 4.56	94.29 ± 15.54	77.95	0.00**
BMI	21.69 ± 3.23	27.40 ± 1.30	35.63 ± 5.58	101.08	0.00**

F: ANOVA Test *P-value <0.05 is significant **P- value ≤0.001 highly significant

As regards, the impact of BMI on spirometric parameters, table 2 showed a statistical significant decrease in the spirometric parameters as BMI increases.

Table (2): The impact of BMI on spirometric parameters

	Groups	**ANOVA test**

ISSN: 1343-4292
Volume 140, Issue 01, April, 2022

	Normal weight group (n = 20)	Overweight group (n = 30)	Obese group (n = 30)	F	P-value
FVC	94.05 ± 13.73	81.70 ± 16.58	72.95 ± 14.55	13.14	0.012*
FEV ^{1}	95.40 ± 11.89	86.54 ± 13.28	79.10 ± 10.69	11.77	0.00**
FEV1/FVC %	85.35 ± 6.70	80.50 ± 6.36	74.05 ± 5.61	20.30	0.00**
FEF 25 -75 %	79.64 ± 5.01	75.79 ± 5.06	69.67 ± 5.91	22.76	0.00**

F: ANOVA Test *P-value <0.05 is significant **P- value ≤0.001 highly significant

Then we assessed the correlation between the BMI and spirometric parameters in figure 1(A, B, C, D) and it was found according to Spearman's rank correlation coefficient analysis, the BMI was negatively correlated with FVC (r= -0.520, p=0.00**), FEV^1(r= -0.499, p=0.00**), FEV^1/FVC % (r= -0.633, p=0.00**), and FEF 25 -75 %(r= -0.649, p=0.00**).

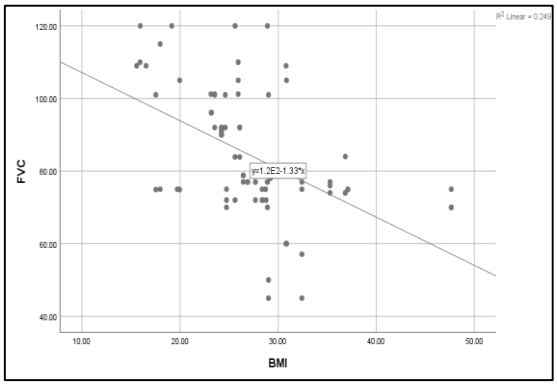

Figure (1A): Correlation between BMI and FVC

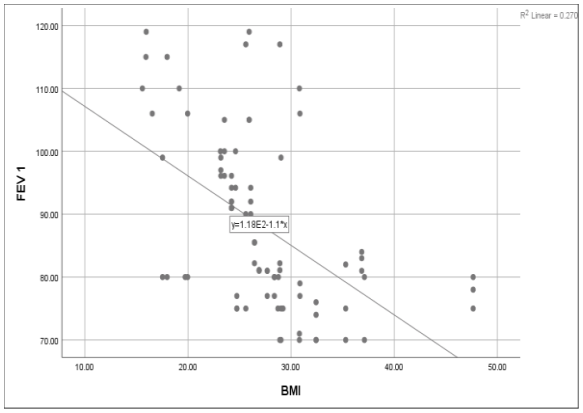

Figure (1B): Correlation between BMI and FEV^1

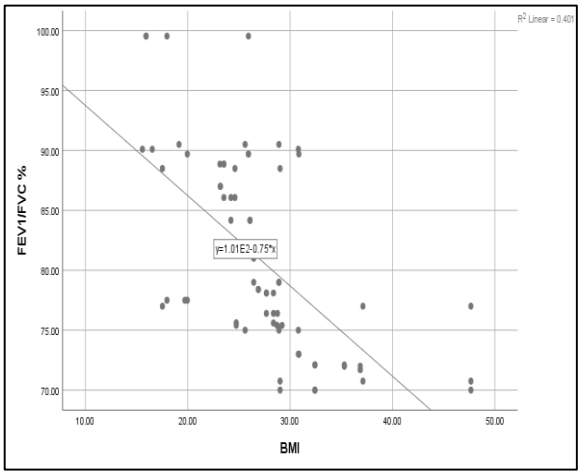

Figure (1C): Correlation between BMI and FEV1/FVC %

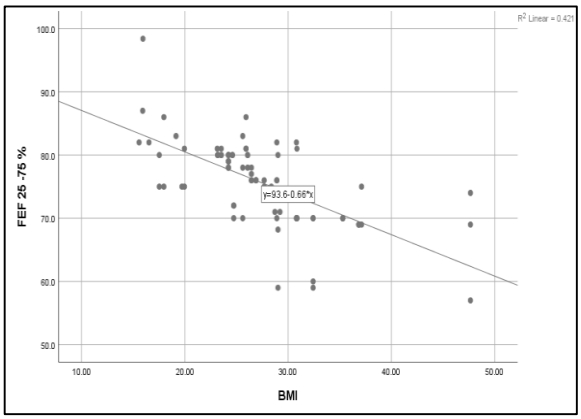

Figure (1D): Correlation between BMI and FEF 25-75 %

4. Discussion

Obesity is considered one of the major public health issues and negatively affects lung function and reduces both dynamic and static lung volumes [14], [15]. Affection of Lung function by age, gender, and smoking status has been confirmed [16], [17]. But so far no particular decision is received regarding the impact of obesity on lung function because multiple standards for obesity are followed [18]. Thus our study aimed to detect the impact of BMI on spirometric parameters among a sample of the adult population in Egypt and to detect which of the spirometric parameters is majorly affected.

We retrospectively collected the data about adult participants with normal spirometric parameters in the duration from March 2019 to October 2019 in Ain Shams University hospital and it was found that all participants with the previous criteria were male and we divided them into groups according to their BMI (normal weight, overweight and obese group).

It was found that there was a statistically significant decrease in spirometric parameters as BMI increased and that the BMI was negatively correlated with spirometric parameters.

The negative effect of increased BMI on the respiratory system can be clarified directly by fat deposition presence in the chest wall and abdomen that restrict the movement of the respiratory muscles [19], [20]. Another cause is inflammatory cytokines production from the adipose tissue accompanied by an increase in immune cells that produce inflammatory and structural changes within the small airways [19], [20].

[18] performed their study on 770 subjects living in Xi'an, China and it was found that FVC was the detectable parameter that decreased in obese people while the other spirometric parameters were not affected and it was found also that FEV1, FVC, and PEF were low in underweight people and it was matched with our study in the decrease of FVC parameter with increase BMI but we didn't include the underweight people in our study.

While [21], carried his study among 95 teenagers aged 18 to 22 Years and it was found that obesity had insignificant effects on most of the spirometric parameters except for FEV1/FVC values in obese females and detectable negative correlation was found between FEV1/FVC (in both gender), forced expiratory flow 50% (FEF50%) (in males only) and BMI and they explained their results due to the short duration of obesity of their participants, as they were late adolescents with an average age of 19 years old.

Mafort and colleagues found that obesity has a negative effect on lung function depending on the pattern of body fat distribution, whether central or peripheral [20]. They claimed that the reduction in lung function is common and related to central fat distribution (thorax and abdomen) rather than peripheral distribution (hips and thighs) but in our study, we didn't assess the pattern of fat distribution.

So there is still controversy in the studies on the impact of obesity on spirometric parameters and insignificant results were reported [22- 24] but the major complications of obesity are the increase of the demand for ventilation, increase work of breathing, and diminished respiratory compliance. Our limitation in this study that it was retrospective and the sample size was small.

5. Conclusion

A high BMI has a significant impact and negative correlation on most of the spirometric parameters (FVC, FEV1, FEV1/FVC %, and FEF 25 -75%)

Abbreviation
BMI: body mass index
FEV1: forced expiratory volume in first second
FVC: forced vital capacity
FEF: forced expiratory flow
Kilograms: Kg
Meter: m

6. Reference

[1] Ng M, Fleming T, Robinson M, et al(2013). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study. Lancet;384:766–81.

[2] Obesity(2000). preventing and managing the global epidemic. Report of a WHO consultation. World Health Organization technical report series ; 894:i–xii, 1–253.

[3] Nuttall FQ(2015). Body mass index: Obesity, BMI, and health: A critical review. Nutrition Today, Vol. 50, No. 3: 117-28

[4] Pasco JA, Holloway KL, Dobbins AG, Kotowicz MA, Williams LJ, and Brennan SL. (2014). Body mass index and measures of body fat for defining obesity and underweight: A cross sectional ,population-

based study. BMC Obesity, Vol. 1, No. 1: 1-7.

[5] World Health Organization(2021). Non communicable diseases. Available online at: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases (accessed July 14, 2021).

[6] Bai J, Peat JK, Berry G, Marks GB, and Woolcock AJ. (1998). Questionnaire items that predict asthma and other respiratory conditions in adults. Chest;114:1343–1348

[7] Sahebjami H(1998). Dyspnea in obese healthy men. Chest ;114:1373–1377.

[8] Ruppel, Gregg L.,and Paul L. Enright(2012). Pulmonary function testing. Respiratory Care, Vol. 57, No. 1:. 165-175

[9] Jones RL and Nzekwu MM(2006). The effects of body mass index on lung volumes. Chest;130:827–833.

[10] Fortis S, Corazalla EO, Wang Q, Kim HJ (2015). The difference between slow and forced vital capacity increases with increasing body mass index: A paradoxical difference in low and normal body mass indices. Respiratory Care, Vol. 60, No.1:. 113-118

[11] Robinson, PD(2014). Obesity and its impact on the respiratory system. Paediatric Respiratory Reviews, Vol. 15, No. 3: 219-226,

[12] Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, Crapo R, Enright P, van der Grinten CP, Gustafsson P, Jensen R, Johnson DC, MacIntyre N, McKay R, Navajas D, Pedersen OF, Pellegrino R, Viegi G, Wanger J and ATS/ERS Task Force. (2005). Standardization of spirometry. Eur Respir J.;26(2):319–338.

[13] Barreiro TJ and Perilo I(2004).An approach to interpreting spirometry. Am Fam Physician;69(5):1107-1014

[14] Peralta GP, Marcon A, Carsin AE, Abramson MJ, Accordini S, Amaral AF, Antó JM, Bowatte G, Burney P, Corsico A, Demoly P, Dharmage S, Forsberg B, Fuertes E, Garcia-Larsen V, Gíslason T, Gullón JA, Heinrich J, Holm M, Jarvis DL, Janson C, Jogi R, Johannessen A, Leynaert B, Rovira JM, Nowak D, Probst-Hensch N, Raherison C, Sánchez-Ramos JL, Sigsgaard T, Siroux V, Squillacioti G, Urrutia I, Weyler J, Zock JP, and Garcia-Aymerich J. (2020). Body mass index and weight change are associated with adult lung function trajectories: The prospective ECRHS study. Thorax, Vol. 75, No. 4: 313-320

[15] Littleton SW and Tulaimat A (2017). The effects of obesity on lung volumes and oxygenation. Respiratory Medicine, Vol. 124, 2017: 15-20

[16] Crapo RO and Jensen RL(2003). Standards and interpretive issues in lung function testing. Respir Care;48:764–772

[17] Pelzer AM and Thomson ML(1996). Effect of age, sex, stature, and smoking habits on human airway conductance. J Appl Physiol;21:469–476.

[18] Wang S, Sun X, Hsia TC, Lin X, Li M. (2017). The effects of body mass index on spirometry tests among adults in Xi'an, China. Medicine (Baltimore);96(15): 6596.

[19] Dixon, Anne E., and Ubong Peters(2018). The effect of obesity on lung function. Expert Review of Respiratory Medicine, Vol. 12 No. 9:755-67,

[20] Mafort TT, Rufino R, Costa CH, and Lopes AJ (2016). Obesity: systemic and pulmonary complications, biochemical abnormalities, and impairment of lung function. Multidisciplinary Respiratory Medicine, Vol. 11, No. 1:. 1-11.

[21] Walid M, Mohammed A, Narayanan SN, and Merghani TH(2021).The Impact of Body Mass Index on Spirometric Parameters of Late Adolescents. International Journal of Medical Research & Health Sciences, 10(7): 10-18.

[22] Ceylan E, Cömlekçi A, Akkoçlu A, Ceylan C, Itil O, Ergör G,and Yeşil S (2009). The effects of body fat distribution on pulmonary function tests in the overweight and obese. Southern .Medical Journal, Vol. 102, No. 1: 30-35.

[23] Gabrielsen AM, Lund MB, Kongerud J, Viken KE, Røislien J, and Hjelmesæth J. (2011). The relationship between anthropometric measures, blood gases, and lung function in morbidly obese white subjects. Obesity Surgery, Vol. 21, No. 4:485-489.

[24] Pekkarinen E, Vanninen E, Länsimies E, Kokkarinen J, and Timonen KL (2012). Relation between body composition, abdominal obesity, and lung function. Clinical Physiology and Functional Imaging, Vol. 32, No. 2:83-88.