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A CROSS-SECTIONAL STUDY TO DETERMINE THE EFFECT OF OBESITY ON PULMONARY FUNCTION TESTS USING "BODY *BOX PLETHYSMOGRAPHY*"

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ABSTRACT: Introduction: As compared to healthy weight subjects, obese individuals are more susceptible to respiratory infections and obese patients with respiratory disease have higher hospitalization rates. This cross-sectional study was conducted to observe the effect of obesity on pulmonary function tests in otherwise healthy adults. **Materials and Methods:** Study comprised of 180 subjects in the age group of 18-65 years divided into 3 groups: Group I comprising 60 normal subjects with body mass index (BMI) between 18.5-24.9 Kg/m^2, Group II comprising 60 overweight subjects with BMI between 25-29.9 Kg/m^2, and, Group III comprising 60 obese subjects with BMI $\geq$ 30 Kg/m^2. It was carried out in Department of Physiology, Government Medical College, Patiala from December 2020 to November 2022. The pulmonary function tests were recorded by spirometry using body box plethysmograph. **Results:** All respiratory parameters exhibited statistically significant decrease in obese groups as compared to normal and overweight groups. Lung volumes showed significant differences in relation to BMI. FVC, FEV_1 and FEV_3 showed significant decrease in relation to BMI with Group III (obese) as compared to Group I (normal) and Group II (overweight) with $p<0.01$ in both cases. FEV_1/FVC showed a significant increase in obese (91.25 ± 6.08) as compared to normal (86.83 ± 7.7) and overweight (86.03 ± 6.9) groups. **Conclusion:** Obesity of especially marked degrees with BMI of more than 30 kg/m^2 alters the respiratory physiology and negatively affects the spirometric parameters. Restrictive pattern was the most common abnormality observed in the spirometry of obese patients.

INTRODUCTION: Obesity is one of the most common health problems and is acknowledged as an "escalating epidemic" worldwide [1]. The frequency of obesity has almost tripled worldwide since 1975. More over 1.9 billion persons over the age of 18 were categorized as overweight in 2016, and over 650 million of them were obese [2]. Because obesity is so common, it has been classified as a non-communicable disease.

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One billion people globally, including one in five women and one in seven men, are expected to suffer from obesity by 2030, according to the World Obesity Federation [3]. According to data from the World Obesity Atlas 2022, several nations may not only fall short of the WHO's 2025 goal to stop the obesity epidemic at 2010 levels, but the number of obese people worldwide may even double.

Obesity affects more than 135 million people in India, where its prevalence is increasing more quickly than the global average and greatly increasing the burden of non-communicable diseases [4, 5]. A chronic condition of low-grade inflammation, obesity is typified by an excessive buildup of body fat that is harmful to one's health. Obesity is caused by a number of causes, such as genetic predispositions, excessive consumption of high-calorie meals, sedentary lifestyles, and inadequate exercise [6]. For diseases such as pulmonary hypertension, obesity hypoventilation syndrome (OHS), obstructive sleep apnoea, and asthma, it is an important risk factor and disease modifier. Obesity also exacerbates the consequences of chronic obstructive pulmonary disease (COPD) and acute respiratory distress syndrome (ARDS). Obese people are more susceptible to respiratory infections than people of a healthy weight, and hospitalization rates are higher for those who suffer from respiratory conditions [7, 8, 9].

There are three severity levels for excess body fat: mild, moderate, and severe. Based on the pattern of fat distribution, obesity can be classified into two main phenotypes: central and peripheral. Increased visceral fat buildup in the abdomen, thorax, and surrounding organs is a hallmark of central (abdominal or android) obesity. On the other hand, peripheral (gynoid) obesity is characterized by increased subcutaneous fat accumulation in regions like the limbs, thighs, and hips. Central obesity is linked to metabolic syndrome, which is further linked to asthma and decreased lung function in both adults and children. This is because visceral fat has a higher metabolic activity than subcutaneous fat [10, 11, 12]. Because of structural alterations in the thoraco-abdominal area that limit diaphragm and rib mobility, both of which are necessary for efficient breathing, central obesity may also have a greater direct impact on pulmonary mechanics than peripheral obesity [8, 9, 13].

The metabolic syndrome is exacerbated by disorders like insulin resistance, dyslipidemia, hypertension, and poor glucose metabolism, all of which are linked to abdominal obesity. Excessive calorie intake causes inflammation in adipose tissue and the systemic circulation, which raises M1 macrophages that release inflammatory cytokines such as interleukin-6, adiponectin, IL-1β, tumour necrosis factor-α, and leptin, according to studies conducted in animal models [14, 15]. Furthermore, mast cells, which are involved in asthma, have also been linked to the emergence of obesity; their presence in adipose tissue may be a factor in the production of adipocytokines [16, 17, 18]. Numerous measurements, such as body mass index (BMI), waist-hip ratio, and body surface area, can be used to evaluate obesity. Weight in kilograms divided by height in meters squared, or Kg/m^2, is the formula used to compute BMI. A body mass index (BMI) of 18.5-24.9 kg/m^2 is regarded as normal in adults, 25-29.9 kg/m^2 as overweight, and 30 kg/m^2 or more as obese [9]. The most precise techniques for assessing lung function are spirometry and plethysmography, which measure lung volumes and capacities [8].

FEV_1 and FVC are important measures of pulmonary function that are impacted by childhood lung development, adult peak function, and age-related decline. Peak pulmonary function is correlated with race and gender, while other factors including smoking, occupational exposures, and air pollution also play a part. Excess body fat is associated with poorer lung function after controlling for factors such as age, sex, height, race, asthma, and smoking status [19]. By demonstrating that people with normal body weight but high body fat percentages suffer from identical declines in lung function and indications of metabolic dysregulation as those who are overweight or obese, Yuan-Yuei Chen *et al*.' research challenged conventional ideas of obesity [20]. It's important to remember that some people who are quite obese might have normal blood gas, lung volume, and spirometry readings [8]. The goal of this research was to improve knowledge of the complex connection between lung function and body composition.

MATERIALS AND METHODS: 180 subjects, both male and female, participated in the current cross-sectional study. They were split into three groups: Group I included 60 normal subjects with a BMI between 18.5-24.9 kg/m^2, Group II included 60 overweight subjects with a BMI between 25-29.9 kg/m^2, and Group III included 60 obese subjects with a body mass index $\geq$ 30 kg/m^2 in order to examine the impact of BMI on pulmonary function tests. After obtaining informed written consent on a pre-designed proforma, this study was carried out in the Department of Physiology at the Government Medical College in Patiala from December 2020 to November 2022. The institutional ethics committee gave its approval to this work [IEC approval number: BFUHS/2K21p-

TH/14870]. Exclusion-inclusion criteria served as the basis for the subject selection process.

Inclusion Criteria:

1. Age range of 18 to 65.
2. Normal subjects with body mass index (BMI) of 18.5-24.9 kg/m^2, overweight patients with BMI of 25-29.9 kg/m^2, and obese subjects with BMI of >/= 30 kg/m^2.

Exclusion Criteria:

1. Individuals who smoke.
2. Individuals with respiratory conditions.
3. Individuals that exhibit apprehension, anxiety, or a lack of cooperation.
4. Individuals having a history of depression or anxiety.

Study Design: In compliance with the proforma that is supplied, all subjects were interviewed and had pertinent medical histories obtained. All subjects were given an explanation of the proper test procedure. Comprehensive anthropometric measures were made in each of the chosen cases. A digital electronic scale was used to measure the subject's weight, without shoes, to the nearest 0.1 kg. A measuring tape was used to record the subject's height (in centimetres) while they were standing barefooted on the floor, with their heels slightly apart and their buttocks and back touching the wall. Quetlet's index was used to calculate the body mass index [21]. Weight (kg) divided by Height squared (in m^2) equals BMI. The Medisoft "BODYBOX 5500" body box plethysmograph was used to conduct the pulmonary function testing. The volume-constant Bodybox plethysmograph is a Dubois-type chamber that is roughly 700–1000 L in volume and shaped like a telephone box with glass walls. Conventional devices, like pneumotachographs, which are calibrated using syringes that provide a specified volume, were used to record the respiratory flow rate.

Procedure: The cabin door was left open since the body box was used for the spirometry test. The accuracy of the system was confirmed once it was calibrated that same day.

- After being instructed to take off the shoes, the participant was instructed to sit up straight on the chair inside the box with their feet flat on the ground. The subject was made comfortable.
- The diaphragm was in its normal position, the subject's chest frame was undistorted, and the patient valve was adjusted to the height of the subject's mouth while they were seated normally.
- A single subject barrier filter was used to link the subject to the mouthpiece of the apparatus.
- To get the best results, the patient was made to wear a nasal clip during every test.
- The subject was fully confident and acquainted with the equipment and test procedure. The subject received repeated demonstrations of the process. Based on the American Thoracic Society/European Respiratory Society (ATS/ERS) standards included into the program, the best three acceptable movements were taken as the final values, and the flow volume curve was collected while sitting at the same time of day.
- Subject was instructed in the method of measurement - a period of tidal volume measurement followed by a full inspiration and, without hesitation, a forced expiratory effort to residual volume; followed by a full inspiration.
- The following metrics were noted: FEV_1/FVC (%) (Tiffeneau-Pinelli index), Forced Vital Capacity (FVC), Forced Expiratory Volume in One Second (FEV_1), and Forced Expiratory Volume in Three Seconds (FEV_3) [22].

Statistical Analysis: Charts and graphs were used to compile the results. The anthropometric and lung function parameters' means and standard deviations were determined. One-way ANOVA was used to statistically examine the three groups' mean differences, and post-hoc analysis was performed for intergroup comparison. In a similar way, in order to remove gender bias, the results were statistically examined for each gender independently. Statistical significance was established when the p-value was less than 0.05.

RESULTS: Based on their BMI, 180 patients were split up into three groups of 60 subjects each.

Group I had mean age of 25.82 ± 7.416 years, Group II had mean age of 28.08 ± 8.627 years, and Group III had mean age of 32.7 ± 16.539 years **Table 1** shows comparison of mean BMI among 3 groups with highly significant differences [**Fig. 1**]. **Table 2** shows gender distribution among three groups: Group I had 48.33% females and 51.67% males with normal BMI; Group II had 53.33% females and 46.67% males with overweight BMI; and Group III had 45% females and 55% males with obese BMI [**Fig. 2**]. **Table 3** summarizes the mean pulmonary function parameter values for each of the three groups. When Group I and II, Group I and III, and Group II and III were compared, the spirometric values FVC, FEV_1, and FEV_3were found to be significantly decreased in obese and overweight groups (p<0.01) **[Fig. 3].** When Group I and III, and Group II and III were compared, the mean values of FEV_1/FVC (%) showed a substantial increase in obese group (p<0.01) **[Fig. 4].**

TABLE 1: COMPARISON OF MEAN OF AGE AND BMI AMONG ALL GROUPS

Parameter	Mean ± SD			p Value	Sig.
	Group I	Group II	Group III		
Age (in Years)	25.82 ± 7.416	28.08 ± 8.627	32.7 ± 10.539	<0.01	HS
BMI (in Kg/m^2)	22.165±1.671	26.871 ± 1.046	32.900 ± 2.195	<0.01	HS

TABLE 2: GENDER DISTRIBUTION AMONG GROUPS

Group	Female		Male		Total
	Count	% age	Count	% age	
I	29	48.33%	31	51.67%	60
II	32	53.33%	28	46.67%	60
III	27	45%	33	55%	60

TABLE 3: COMPARISON OF SPIROMETRIC PARAMETERS AMONG ALL GROUPS

Parameter	Mean ± SD			p Value	Post HOC Analysis
	Group I	Group II	Group III		
FVC (L)	3.54 ± 0.674	2.818 ± 0.544	2.339 ± 0.551	<0.01	I vs II – HS I vs III – HS II vs III – HS
FEV_1 (L)	3.03 ± 0.539	2.419 ± 0.49	2.139 ± 0.516	<0.01	I vs II – HS I vs III – HS II vs III – HS
FEV_3 (L)	3.49 ± 0.651	2.775 ± 0.515	2.337 ± 0.551	<0.01	I vs II – HS I vs III – HS II vs III – HS
FEV_1/FVC (%)	86.83 ± 7.744	86.03 ± 6.911	91.25 ± 6.08	<0.01	I vs II – NS I vs III – HS II vs III – HS

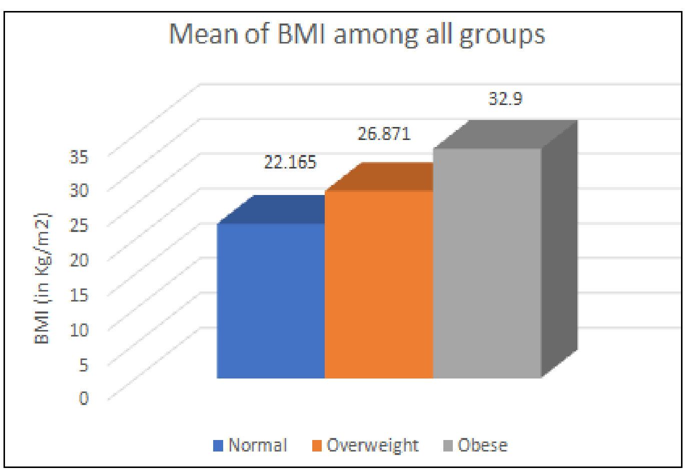

FIG. 1: COMPARISON OF MEAN OF BMI AMONG ALL GROUPS

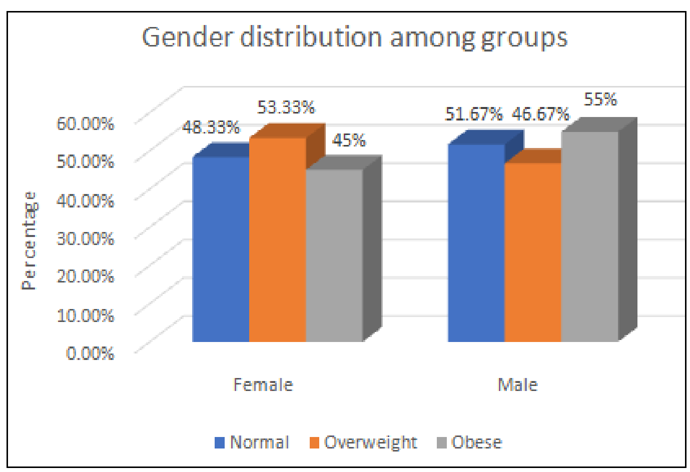

FIG. 2: GENDER DISTRIBUTION AMONG GROUPS

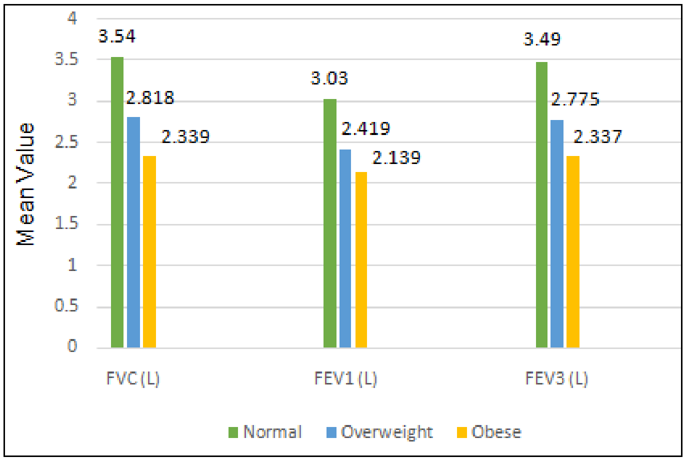

FIG. 3: COMPARISON OF RESPIRATORY PARAMETERS AMONG THREE GROUPS ACCORDING TO BMI

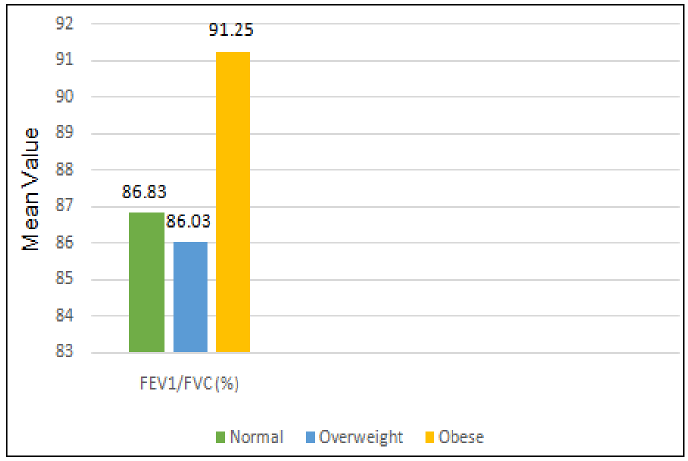

FIG. 4: COMPARISON OF MEAN OF FEV_1/FVC AMONG ALL THREE GROUPS

DISCUSSION: A chronic illness that has a detrimental effect on health, obesity is characterized by an excessive buildup of body fat [23]. Numerous comorbidities, such as diabetes, dyslipidemia, hypertension, and vascular problems, are frequently associated with this illness [24, 25]. Obesity-related respiratory alterations also lower the quality of life for those who are impacted and lead to functional restrictions [23]. Because fat builds up in the thorax and inhibits diaphragm mobility, obese people may have a deterioration in pulmonary function [26]. Additionally, these problems are made worse by systemic and local inflammation from adipose tissue, which makes managing asthma in obese people more difficult [27]. In his study of 2,130 men, John Hutchinson who developed the spirometer, discovered that pulmonary function was highly influenced by age, height, and illness. He found that, once height was adjusted, vital capacity rose with weight until a certain point, at which point it started to fall in people who were extremely overweight [28, 29].

We discovered notable variations in lung sizes according to Body Mass Index (BMI) in our research. When BMI increased, there was a decrease in forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and forced expiratory volume in three seconds (FEV_3). In contrast, the FEV_1/FVC ratio rose significantly ($p<0.01$) in the obese group as compared to the normal and overweight groups. There was no gender bias in our results, as the spirometric measurements for males and females in the three groups matched. In line with our findings, Kaur G *et al.*[30] found that FVC, FEV_1, and FEV_3 significantly decline when comparing normal and obese populations. Additionally, Ochs-Balcom HM *et al.*[14] found a significant inverse relationship between FVC and abdominal fat. FEV_1 levels drop in obese people, according to Steier J *et al* [7] and Sin DD *et al* [31], and Al-Bader WR *et al* [32] observed comparable results in Kuwaiti adults. Fat buildup in the thoracic and abdominal regions may be the cause of obese people's decreased pulmonary function since it mechanically restricts chest expansion and diaphragm movement. Reduced lung function and greater respiratory effort are the results of this restriction. Furthermore, obesity may cause the release of inflammatory markers that negatively impact lung tissue and decrease lung compliance, including interleukin-6, tumour necrosis factor-alpha, leptin, and adiponectin.

According to Thyagarajan B *et al* [19], those with high BMI had higher FEV_1/FVC, which is consistent with our results and could be because of a decrease in lung elasticity that results in a greater decrease in FVC than FEV_1. Our findings are supported by Wannamethee SG *et al.*, [33] research on older males, which showed that a higher BMI was associated with a raised FEV_1/FVC ratio and that a higher BMI was associated with a lower chance of low FEV_1/FVC, which indicates airway obstruction. However, because their study categorized obesity using a Chinese norm (BMI $\geq$ 24 kg/m^2), our results are different from those of Wang S *et al* [34], who did not discover a significant decrease in FEV_1 among obese patients. This could be because of methodological differences. Age, ethnicity, geography, and various obesity criteria can all have an impact on the link between BMI and pulmonary function tests (PFTs), and these disparities may also be a reflection of ethnic variances. The findings of Paralikar SJ *et al* [6], who examined pulmonary functions in 30 obese teenage males in comparison to an equivalent number of age-matched controls, are in contrast to ours. Their results showed a drop in FEV_1/FVC and implied airflow limitation due to airway narrowing without substantial obstruction, as seen by a decline in FEV_1. This disparity might result from our study's bigger, more inclusive sample size or from variations in the subjects ages. Research by Reyes Noriega N *et al* [35] has indicated that obese patients with asthma have diminished lung function in terms of functional residual capacity (FRC), residual volume (RV), expiratory reserve volume (ERV), the FEV_1/FVC ratio, and $FEF_{25-75\%}$ due to mechanical fat loading on the diaphragm and central adiposity when compared to non-obese asthmatic patients.

Anita Jain *et al* [36] showed that pulmonary functions such as peak expiratory flow rate and maximum voluntary ventilation decreased significantly (<0.05) in obese people when compared with non-obese people. Charoensittisup P *et al* [37] showed that after 1 year of follow-up, change in abdominal adiposity exerted significant negative effect on lung function change specific to FEV_1/FVC, $FEF_{25-75\%}$/FVC, and $FEF_{25-75\%}$. Study by Elsaidy WH *et al* [38] identified significant variations between BMI categories and specific lung function parameters. FEV_1/FVC ratio showed a decline with increasing BMI. A study on 103 children (over-weight/obese = 56, control = 47) showed that percent predicted (%) FEV_1 and FVC were significantly lower in the obese/over-weight group as compared to control group. A significant negative correlation was found between FEV_1 (%) and FVC (%) and that of BMI [39]. Increasing BMI has deleterious effects on static and dynamic pulmonary volumes and causes airway flow limitation and increased airway hyper responsiveness [40]. Thus, our findings are in line with many previous and recent researches.

Strengths:

1. In this research, pulmonary function was tested using a body box plethysmograph, which has been the gold standard for measuring lung volumes for decades. Compared to handheld portable spirometers, it is more sensitive, and the results meet ATS/ERS standards. Thus, it aids us in obtaining a more accurate analysis.

2. The mean age of the study's obese participants is 32.7±10.539 years. After controlling for other variables, the only explanation for the reduction in lung function measurements at this age is obesity in an otherwise healthy adult.

3. Both genders are included in this study, and we have examined the effects of obesity in both genders separately as well as jointly, with comparable findings. This removes any gender bias, and the loss in lung function can be attributed to obesity.

4. In this study, lung function tests such as FVC, FEV_1, FEV_3, and FEV_1/FVC are analyzed primarily because they are straightforward to do and trustworthy indicators that aid in the early screening of pulmonary disorders.

Limitations and Future Prospects: Although we have worked really hard to complete this research project and have made the greatest use of the resources at our disposal, it is a humble fact that research is a dynamic field that is constantly open to improvement. Overcoming the following constraints in future study can increase its effectiveness:

1. This study involved 180 participants and was carried out across two years, from December 2020 to November 2022. The COVID-19 pandemic disrupted the first half of the study. Lockdowns enforced by the government dominated most of this period, which resulted in a shortage of subjects and widespread reluctance to do pulmonary function testing. All of this led to a restricted selection of research subjects and a lack of time. Future research should plan a prospective cohort study with a bigger sample size to improve the generalizability of findings.

2. For convenience in this investigation, we have utilized body mass index (BMI) as the main predictor of obesity. However, BMI is a crude indicator of obesity since it does not take into

account the distribution pattern of fat. There is a variance of fat distribution patterns among different races, ethnicities and countries, which in turn may cause alteration of lung function. In the future, body fat percentage and other metrics that take into account the body's fat distribution should be employed as indicators of obesity.

3. In order to counter the lack of subjects brought on by the COVID-19 epidemic, we included participants who were between the ages of 18 and 65. Future research can be designed to eliminate age-related bias since age is a significant component that also affects lung function testing.

4. Finally, by conducting longitudinal studies, it would be interesting to examine the relationship between changes in body weight and their impact on lung functions in obese individuals.

CONCLUSION: In conclusion, when compared to the normal group, pulmonary function tests show a decline in the obese and overweight groups, with the obese group experiencing a more noticeable decline. Even in the absence of a specific respiratory condition, obesity lowers respiratory well-being and can have major effects on pre-existing pulmonary conditions. Obesity is therefore a challenging health hazard. Our findings are clinically relevant because obese people who seek treatment for breathing problems are frequently misdiagnosed and treated inappropriately, although weight loss and basic lifestyle modifications can produce better outcomes than medical intervention.

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CONFLICTS OF INTEREST: NIL

REFERENCES:

1. Aoyagi K, Kusano Y, Takamura N, Abe Y, Osaki M and Une H: Obesity and cardiovascular risk factors among men and women aged 40 years and older in a rural area of Japan. J Physiol Anthropol 2006; 25(6): 371–5.
2. Nuertey BD, Alhassan AI, Nuertey AD, Mensah IA, Adongo V and Kabutey C: Prevalence of obesity and overweight and its associated factors among registered pensioners in Ghana; a cross sectional studies. BMC Obes 2017; 4: 26.
3. Introduction, World Obesity Atlas. World Obesity Federation. March 2022; 11.
4. Ahirwar R and Mondal PR: Prevalence of obesity in India: A systematic review. Diabetes Metab Syndr 2019; 13(1): 318-21.
5. Luhar S, Timæus IM, Jones R, Cunningham S, Patel SA and Kinra S: Forecasting the prevalence of overweight and obesity in India to 2040. PLoS One 2020; 15(2): 0229438.
6. Paralikar SJ, Kathrotia RG, Pathak NR and Jani MB: Assessment of pulmonary functions in obese adolescent boys. Lung India 2012; 29(3): 236-40.
7. Steier J, Lunt A, Hart N, Polkey MI and Moxham J: Observational study of the effect of obesity on lung volumes. Thorax 2014; 69(8): 752-9.
8. Melo LC, Silva MA and Calles AC: Obesity and lung function: a systematic review. Einstein (Sao Paulo) 2014; 12(1): 120-5.
9. Dixon AE and Peters U: The effect of obesity on lung function. Expert Rev Respir Med 2018; 12(9): 755-67.
10. Backer V, Baines KJ, Powell H, Porsbjerg C and Gibson PG: Increased asthma and adipose tissue inflammatory gene expression with obesity and Inuit migration to a western country. Respir Med 2016; 111: 8-15.
11. Thomsen SF, Ulrik CS, Kyvik KO, Larsen K, Skadhauge LR, Steffensen I: The incidence of asthma in young adults, Chest 2005; 127: 1928-34.
12. Thomsen SF, Ulrik CS, Kyvik KO, Larsen K, Skadhauge LR, Steffensen IE: Risk factors for asthma in young adults: a co-twin control study, Allergy 2006; 61: 229-33.
13. Mehari A, Afreen S, Ngwa J, Setse R, Thomas AN and Poddar V: Obesity and Pulmonary Function in African Americans. PLoSONE 2015; 10(10): 0140610.
14. Ochs-Balcom HM, Grant BJ, Muti P, Sempos CT, Freudenheim JL and Trevisan M: Pulmonary function and abdominal adiposity in the general population. Chest 2006; 129(4): 853-62.
15. Hotamisligil GS, Shargill NS and Spiegelman BM: Adipose expression of tumor necrosis factor-alpha: direct role in obesity-linked insulin resistance, Sci. New York NY 1993; 259; 87-91.
16. Divoux A, Moutel S, Poitou C, Lacasa D, Veyrie N and Aissat A: Mast cells in human adipose tissue: link with morbid obesity, inflammatory status, and diabetes. J Clin Endocrinol Metab 2012; 97: 1677-85.
17. Sismanopoulos N, Delivanis DA, Mavrommati D, Hatziagelaki E, Conti P and Theoharides TC: Do mast cells link obesity and asthma? Allergy 2013; 68: 8-15.
18. Zhang J and Shi GP: Mast cells and metabolic syndrome, Biochim. Biophys. Acta BBA Mol Basis Dis 2012; 1822: 14-20.
19. Thyagarajan B, Jacobs DR, Apostol GG, Smith LJ, Jensen RL and Crapo RO: Longitudinal association of body mass index with lung function: The CARDIA Study. Respir Res 2008; 9(1): 31.
20. Chen YY, Kao TW, Fang WH, Wang CC, Chang YW and Yang HF: Body fat percentage in relation to lung function in individuals with normal weight obesity. Sci Rep 2019; 9(1): 3066.
21. BMI Classification, Global Database on Body Mass Index. World Health Organization 2006.
22. Yu S, Park S, Park CS and Kim S: Association between the Ratio of FEV_1 to FVC and the Exposure Level to Air Pollution in Neversmoking Adult Refractory Asthmatics Using Data Clustered by Patient in the Soonchunhyang Asthma Cohort Database. Int J Environ Res Public Health 2018; 15(11): 2349.
23. Costa D, Barbalho MC, Miguel GP, Forti EM and Azevedo JL: The impact of obesity on pulmonary function in adult women. Clinics (Sao Paulo) 2008; 63(6): 719-24.

24. Bahia L, Aguiar LG, Villela N, Bottino D, Godoy-Matos AF and Geloneze B: Relationship between adipokines, inflammation, and vascular reactivity in lean controls and obese subjects with metabolic syndrome. Clinic 2006; 61: 433–40.
25. Faintuch J, Horie LM, Schmidt VD, Barbeiro HV, Barbeiro DF and Soriano FG: Obesity, inflammation, vascular reactivity, and cardiocirculatory events. Clinics 2007; 62: 357–8.
26. Boulet LP: Asthma and obesity. Clin Exp Allergy 2013; 43: 8-21.
27. Özbey Ü, Ucar U and Calis AG: The effects of obesity on pulmonary function in adults with asthma. Lung India. 2019; 36(5): 404-10.
28. Hutchinson J: On the capacity of the lungs, and on the respiratory functions, with a view of establishing a precise and easy method for detecting disease by the spirometer. Med Chir Trans 1846; 29: 137–252.
29. Lazarus R, Gore CJ, Booth M and Owen N: Effects of body composition and fat distribution on ventilatory function in adults. Am J Clin Nutr 1998; 68(1): 35-41.
30. Kaur G, Kaur S, Gupta G, & Kaur R: Effect of obesity on lung volumes among adults. International Journal of Research in Medical Sciences 2020; 8(8): 2828-33.
31. Sin DD and Man SF: Impaired lung function and serum leptin in men and women with normal body weight: a population based study. Thorax 2003; 58(8): 695–8.
32. Al-Bader WR, Ramadan J, Nasr-Eldin A and Barac-Nieto M: Pulmonary ventilatory functions and obesity in Kuwait. Med PrincPract 2008; 17(1): 20-6.
33. Wannamethee SG, Shaper AG and Whincup PH: Body fat distribution, body composition, and respiratory function in elderly men. Am J Clin Nutr 2005; 82(5): 996-1003.
34. Wang S, Sun X, Hsia TC, Lin X and Li M: The effects of body mass index on spirometry tests among adults in Xi'an, China. Medicine (Baltimore) 2017; 96(15): 6596.
35. Reyes Noriega N, Del-Río-Navarro BE, Berber A, de Jesús Romero Tapia S and Molina Díaz DJM: Effect of Obesity on Lung Function in the Pediatric and Adult Populations with Asthma: A Review. J Clin Med 2023; 12(16): 5385.
36. Jain A, Dhuria S and Sharma N: To study the effect of obesity on pulmonary functions in adults. Natl J Physiol Pharm Pharmacol 2024; 14(7): 1312-1315.
37. Charoensittisup P, Udomittipong K, Mahoran K and Palamit A: Longitudinal effects of obesity on pulmonary function in obese children and adolescents. Pediatr Res 2025; 97(5): 1644-1649.
38. Elsaidy WH, Alzahrani SA and Boodai SM: Exploring the correlation between body mass index and lung function test parameters: a cross-sectional analytical study. BMC Res Notes 2024; 17(1): 320.
39. Satapathy, Amit K, Das, Rashmi R, Mahapatro, Samarendra, Panigrahi, Manoj K, Bandopadhaya and Debapriya: Effect of body mass index (BMI) on pulmonary functions in children of 6-14 years of age: A cross-sectional study. JFMPC 2022; 11(6): 3156-3160.
40. Shah NM and Kaltsakas G: Respiratory complications of obesity: from early changes to respiratory failure. Breathe (Sheff) 2023; 19(1): 220263

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