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Original Research Article

Evaluation PFT and BMI in Obese V/S Non-Obese Individual in Different Age Groups

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Abstract

Aim: The aim of the present study was to evaluate and compare pft and bmi in obese and non-obese individual in different age groups.

Methods: The present study was carried out in department of Physiology, Government medical college, Bettiah, Bihar, India for one year. A total of 100 subjects - 50 in each of the two BMI categories, i.e., obese, and normal weight were selected by stratified random sampling technique after applying the inclusion and exclusion criteria. Subjects were categorized into the two groups (obese and normal weight) based on the BMI classification according to the WHO standards. Ethical clearance was obtained from the institutional ethics committee before starting the study.

Results: A total of 100 cases (obese = 50, non-obese= 50) were included. Of 50 children with obesity/over-weight, 38 (76%) were boys. Among non-obese, 28 (56%) were boys. The mean (± SD) age of children with obese was 10.6 (± 2.38) years compared to 10.1 (± 2.38) years among the non-obese. The mean (± SD) weight of the non-obese group was 32.4 (± 6.64) kg, and that of the obese group was 56.5 (± 12.8) kg. The mean height (± SD) of the non-obese and obese group was 139 (± 9) cm and 142 (± 12) cm, respectively. The highest mean FVC was in subjects of the non-obese group and the lowest was found in the obese category. The highest mean values 98.55 were in the obese category followed by the overweight category 96.34 and the least values were in the normal weight category 94.35. The ANOVA analysis between the groups indicated that the values were significantly different between the group and the p values were less than 0.05. The FEV1 (liters) values in the non-obese group, the values were 1.85± 0.35 and in the obese group with lowest values 1.48 ± 0.22. The lowest mean values were found to be present in the obese group of subjects. The highest mean values were found in non-obese subjects. The ANOVA analysis revealed the p values were >0.05 hence no significant intra or intergroup difference.

Conclusion: The study concluded that increasing BMI has a negative effect on pulmonary functions. Therefore, awareness to maintain normal BMI by lifestyle modifications and interventions might help us in moving forward for eradication of obesity and impairment of pulmonary functions.

Keywords: Pulmonary Function Test; Obese; Normal Weight; Body Mass Index

Introduction

Over-weight/obesity has become a global pandemic affecting children of all age groups. In the United States (USA), approximately 60% of adults and 25% of children and adolescents can be classified as over-weight/obese. [1,2] Although more studies are needed to ascertain the prevalence of over-weight/obesity in India, the prevalence varies from 7.4% to 36% in different studies. [3-5] Childhood obesity has both short- and long-term health concerns including metabolic syndrome, cardiovascular disease, and type 2 diabetes mellitus during the adolescent period and adulthood. [3,5]

The increase in weight gain (over-weight/obesity) is associated with impairment of pulmonary functions at all age groups. There is increased risk of asthma in children with obesity as compared to controls as reported by Lang et al. [6] Studies have revealed a significant reduction in forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), flow rates [peak expiratory flow rate (PEFR) and forced expiratory flow (FEF25–75%)], maximum voluntary ventilation (MVV), expiratory reserve volume (ERV), and functional residual capacity (FRC) associated with morbid obesity. [7] Reductions in pulmonary functions in relation to the waist-to-hip ratio (WHR) have been observed in adults with obesity. [8] A significant decrease in FRC, ERV, flow rates, and MVV has also been found in children and adolescents with over-weight/obesity. [9,10]

The prevalence of adult overweight and obesity is estimated to rapidly increase worldwide from 937 and 396 million in 2005 to 1.35 billion and 573 million in 2030. [11] India, a country with multiple ethnicities, has a varied prevalence of overweight and obesity moving across from the north to south. Furthermore, the incidence of overweight and obesity has been found to increase with age, with the middle-aged people being under higher risk compared to both their younger and older counterparts. The burden of overweight and obesity in India compared with rest of the world is equally worse with 36.9% and 7.8% of subjects aged between 35 and 44 years being overweight and obese, respectively. [12] This picture is expected to further worsen for the reason that in India the percentage of people in the 30–40 years range is rapidly increasing, to nearly 50% of the entire population. Studies have shown that overweight and obesity are associated with medical disorders such as hypertension, diabetes, cardiovascular diseases, stroke, certain cancers, premature mortality, and respiratory diseases. [13,14]

Obesity can cause various deleterious effects to respiratory function such as alterations in respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, lower control of breathing and limitation in pulmonary function tests (PFTs) and exercise capacity. These changes in lung function are caused by extra-adipose tissue in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm, and lungs. The consequences are decrease in diaphragm displacement, a decrease in lung and chest wall compliance, and an increase in elastic recoil, resulting in a decrease in lung volumes, and overload of inspiratory muscles. These changes are worsened with increase in BMI.

The aim of the present study was to evaluate and compare PFT and BMI in obese and non-obese individual in different age groups.

Materials and Methods

The present study was carried out in department of Physiology, Government medical college, Bettiah, Bihar, India for one year. A total of 100 subjects - 50 in each of the two BMI categories, i.e., obese, and normal weight were selected by stratified random sampling technique after applying the inclusion and exclusion criteria. Subjects were categorized into the two groups (obese and normal weight) based on the BMI classification according to the WHO standards. Ethical clearance was obtained from the institutional ethics committee before starting the study.

Inclusion Criteria

Subjects aged 18-32 years having an apparently normal general health, not practicing any form of breathing exercises or doing regular physical exercises and volunteering for the study by giving a written consent.

Exclusion Criteria

Subjects with known respiratory, cardiovascular and neuromuscular diseases, subjects with thoracic skeletal deformities, thyroid dysfunction, known diabetic subjects and pregnant ladies were excluded from the study. The selected subjects were explained about the purpose of the study. They were also assured that the information and the results of the tests shared will be confidential and will not be passed to any agency or their employer.

• The data were collected using preformed pro forma by history taking and physical examination including measurement of height, weight, and BMI.

• BMI was calculated as weight (in kilograms) divided by height (in square meters) (Quetelet's index)

BMI Calculation

It is to test the clinical obesity. It is calculated by:

BMI (kg/m2) = weight(kg)/height(m)2

PFTs: Following explaining and demonstrating the procedure to the subject, a trial run of the procedure of spirometry was done for each one of them. Subject was asked to sit comfortably in a chair. The complete procedure was explained, all doubts if any were cleared. Subject was instructed to breathe in fully by deep inspiration with nostrils closed and seal the lips around the sterile mouthpiece of spirometer and was asked to forcefully expire as rapidly as possible.

Once the procedure was satisfactorily performed, the final recording of PFT parameters was done on each subject. Three recordings were obtained and the best of them selected for analysis. Forced expiratory volume (FEV) in 1st sec (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, and FEF 25–75% were recorded ½ h after a light breakfast, using portable handheld electronic spirometer which comprises an elongated handle or body having a removable mouthpiece.

Statistical analysis

Sample size was calculated from available data from a previous study comparing the pulmonary function test with over-weight/obesity as compared to normal BMI. Taking into consideration of mean FEV1 (2.2 L ± 0.28) in normal weight as compared to that in children with over-weight/obesity (2.05 L ± 0.28) with a power of 80% and an α-error of 5%, the sample size was calculated to be 55 in each group. Continuous variables were expressed as mean ± SD (standard deviation), and categorical variables were expressed as frequencies and percentages. The data were compared using Student's t-test. Correlation between pulmonary functions and anthropometry was studied using Spearman correlation coefficient (ρ).

Results

Table 1: Baseline parameters of the study population

	Obese	Non-Obese
Age (years)	10.6±2.38	10.1±2.38
Gender		
Male	38 (76)	28 (56)
Female	12 (24)	22 (44)
Weight (kg)	56.5±12.8	32.4±6.64
Height (cm)	142±18	139±8
BMI (kg/m2)	26.62±3.78	16.55±1.75
W: H ratio (WHR) (cm)	0.96±0.05	0.90±0.02
Birth weight (kg)	2.87±0.47	2.87±0.38
SBP (mm hg)	105±10	98±8
DBP (mm hg)	66±8	64±10

A total of 100 cases (obese = 50, non-obese= 50) were included. Of 50 children with obesity/over-weight, 38 (76%) were boys. Among non-obese, 28 (56%) were boys. The mean (± SD) age of children with obese was 10.6 (± 2.38) years compared to 10.1 (± 2.38) years among the non-obese. The mean (± SD) weight of the non-obese group was 32.4 (± 6.64) kg, and that of the obese group was 56.5 (± 12.8) kg. The mean height (± SD) of the non-obese and obese group was 139 (± 9) cm and 142 (± 12) cm, respectively. The BMI of the obese/over-weight group was 26.62 (± 3.78) kg/m2, whereas that of the non-obese was 16.55 (± 1.75) kg/m2. The waist-hip ratio (WHR) in the obese group was 0.96, whereas in the non-obese, it was 0.90.

Table 2: Comparative analysis of FVC, FEV1, FEV1/FVC and FEF 25–75%in different groups

Groups	Frequency (n)	FVC	ANOVA	
		Mean ± SD	f value	P- value
Non-Obese	50	2.28 ±0.62	2.60	0.042
Obese	50	1.95 ±0.25		
Groups	**Frequency (n)**	**FEV1**	**ANOVA**	
		Mean ± SD	**f value**	**P- value**
Non-Obese	50	1.85 ±0.35	0.940	0.145
Obese	50	1.48 ±0.22		
Groups	**Frequency (n)**	**FEV1/FVC**	**ANOVA**	
		Mean ± SD	**f value**	**P- value**
Non-Obese	50	96.34 ± 0.79	3.13	0.020
Obese	50	98.52 ± 1.40		
Groups	**Frequency (n)**	**FEF 25–75%**	**ANOVA**	
		Mean ± SD	**f value**	**P- value**
Non-Obese	50	2.98 ± 0.22	0.856	0.920
Obese	50	2.65 ± 0.35		

The highest mean FVC was in subjects of the non-obese group and the lowest was found in the obese category. The highest mean values 98.55 were in the obese category followed by the overweight category 96.34 and the least values were in the normal weight category 94.35. The ANOVA analysis between the groups indicated that the values were significantly different between the group and the p values were less than 0.05.

The FEV1 (liters) values in the non-obese group, the values were 1.85± 0.35 and in the obese group with lowest values 1.48 ± 0.22. The lowest mean values were found to be present in the obese group of subjects. The highest mean values were found in non-obese subjects. The ANOVA analysis revealed the p values were >0.05 hence no significant intra or intergroup difference.

Discussion

Obesity is a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent health may be impaired. It has become one of the leading global public health problems and one of the underlying causes of non-communicable chronic diseases. [15] It has become one of the leading causes of morbidity and mortality in both developed and developing countries. [16] Obesity in adult is defined as having a body mass index (BMI) that is ≥30 kg/m2. The normal range of BMI is between 18.5 and 24.99 kg/m2. Obesity has strong link with respiratory system.

Several studies show there was physiological changes in lungs of obese individuals. [17] There is notable alteration in respiratory function, pulmonary gas exchange, exercise tolerance, strength and endurance of respiratory muscle and altered respiratory pattern in obese individuals when compared with non-obese. [18] It also cause increase work of breathing by increase in consumption of oxygen and carbon dioxide. [17,19] Obese individuals are more prone to have respiratory symptoms like dyspnea, especially during exercise, even if they do not have respiratory illness are mostly seen in obese individuals. [20,21] Many studies have found that reduced lung expansion in obese individuals is related to a higher body mass index. (BMI). [22] Obesity seems to influence the mechanics of respiratory on and create an adverse effect on lung capacity, thereby reducing the exercise capacity. [23,24]

We found a statistically significant decrease in pulmonary functions with parameters FEV1/FVC and FVC. No significant changes between different groups as far as FEV1 and FEF 25–75% are concerned. The usual type of male obesity is called android obesity with fat deposition in central areas around the chest and abdominal cavity. This fat deposition has a mechanical effect and leads to restriction of expansion of chest by preventing the descent of diaphragm due to increased abdominal visceral fat. The decrease in FVC and FEV1/FVC indicates a restrictive effect on the respiratory system similar findings have been reported by several studies conducted in this field by different investigators. [25-28] The most frequently reported effect of obesity on lung function has been reported as a decrease in functional residual capacity (FRC). [29] This effect reflects a shift in the balance during inflation and deflation due to an increased load of adipose tissue mass around the rib cage and abdominal cavity. [30]

The reduction of downward movement of the diaphragm is likely to decrease TLC by limiting the room for lung expansion on inflation. Secondly, the deposition of fat in subpleural spaces might also reduce the lung volume by reduction of hollow space of chest walls. However, shreds of evidence of respiratory muscle inspiratory and expiratory pressure have been found similar between obese and normal-weight subjects suggesting stiffening of the chest wall as the major determinant of TLC. One parameter likely to be affected by obesity is the resistance or upper airway tone which tends to increase with increasing BMI. Morbid obesity reduces the respiratory functions and reduces the compliance of the chest wall and pulmonary parenchyma. [31,32] Pulmonary volume variables, such as forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC), tend to decrease with increasing BMI. The expiratory flow at 50% of the reduced vital capacity is low compared with the predicted value, based on the predicted vital capacity. Significant differences in expiratory flow at 25% of the reduced vital capacity persisted after normalization, suggesting the possibility of peripheral airway obstruction in obese men. Obese people tend to have an increased demand for ventilation and breathing workload, respiratory muscle inefficiency, decreased functional reserve capacity and expiratory reserve volume, and closure of peripheral lung units. [33,34]

Conclusion

The study concludes that increasing BMI has a negative effect on pulmonary functions. The study was an attempt to bring awareness about variation of lung functions with increase in BMI. The information may help to acknowledge the pulmonary health risks that crop up with increasing BMI and fat accumulation. Awareness to maintain BMI normal by lifestyle modifications and interventions might help us in moving forward for eradication of obesity and impairment of pulmonary functions. Future research with larger sample size, including other measures of obesity such as waist-hip ratio, skin-fold thickness will give more insight into effect of obesity on pulmonary functions.

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