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RESEARCH ARTICLE

EFFECT OF VARIOUS ANTROPOMETRIC PARAMETERS ON FORCED VITAL CAPACITY IN INDIAN MALE ADULTS

[1,*]Harmeet singh and [2]Dr. Manila Jain

[1]PhD Research Scholar, Index Medical College and Hospital, Malwanchal University Indore
[2]Professor and Head Department of Physiology, Index Medical College and Hospital, Malwanchal University Indore

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Corresponding author:
Harmeet singh

ABSTRACT

Background: Obesity is chronic disease characterized by Body Mass Index (BMI) >30 and body fat percentage >20%. It is often associated with non-communicable diseases including cardiovascular diseases, Lung Diseases and is a major cause of morbidity and mortality worldwide. present study aims to assess association of anthropometric parameters of obesity including central obesity indicators and body fat percentage with Lung Function. **Methods:** Total 152 subjects were included for the study, 76 of them were of hypertensive and 76 were controls. All of the participants were subjected to evaluation of obesity parameters. **Results:** BMI, Waist Hip Ratio, Body Fat Percentage and Ponderal index were found to significantly associated with hypertension**. Conclusion:** BMI and body fat percentage and has the significant association with Reduction in lung function by reducing the forced vital capacity.

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INTRODUCTION

Pulmonary function tests (PFT) is used as an essential test for diagnosis and assessment of pulmonary dysfunction and diseases, and effects of treatment. Interpretation of PFT depends on the reference values that are obtained from studies in the healthy subjects with the same anthropometric, ethnic, socioeconomic, and environmental characteristics. These anthropometric parameters include height and weight. These have been taken into account to calculate predicted value of the PFT parameters (Miller MR, 2005). However weight or body mass comprises of fat free mass and fat mass. And also there may be variation in subcutaneous fat in people with a normal BMI. And people having central obesity or increased waist circumference that is not taken into account for predicted values of pulmonary function testing. People who do regular exercise may have higher fat free mass and person with the sedentary lifestyle may have a higher fat mass.

Thus individuals with same mass may have different body composition. General population display wide variation in lifestyle; some do regular exercise while some have sedentary lifestyle and develop varied forms of obesity as a result. Body composition also varies among different age groups and thus Fat percentage differs in amongst the different age groups. Whilst It increases with age, the fat percentage values that are normal for young age, are classified as obese in older individuals. Obesity is prevalent in both developed and developing countries and prevalence is on rise currently. In 2015 there were 2.3 billion overweight adults and over 700 million obese worldwide and Approximately 2.8 million deaths are reported as a result of being overweight or obese (O'Connor DW, 2013) India is following a trend of other developing countries that are steadily becoming more obese. In India, more than 135 million individuals were affected by obesity (Ahirwar R. 2019). Several systemic complications are associated with obesity, some of which lead to severe impairment of organs and tissues.

These complications involve mechanical changes caused by the accumulation of adipose tissue and the numerous cytokines produced by adipocytes (Murray CJ, 1997). Obesity may be associated with a number of pulmonary complications (Park JE, 2012). In contrast, athletes are known to have better respiratory function. We have come across the studies where relation between body mass index and pulmonary function test parameter was studied (Wang DY 2010) (Paralikar SJ, 2018). However body mass index may be high both in athletes as well as obese but their composition may be different. Thus body composition would be a better parameter than body mass index. Studies regarding relation between body composition and pulmonary function test have been done in foreign countries. They found contradictory results in males and females (Park JE 2012) (Wang DY 2010). In India, similar studies had been done, however these studies had focused on young individual (adolescent and age group of 18 to 21 years) (Joshi AR, 2008) (Paralikar SJ, 2018). Measuring anthropometric indices are cheap and easy to use techniques for the assessment of nutritional status of an individual. In the present study, we have made an effort to find the relation of Forced Vital Capacity (FVC) and anthropometric parameters including BMI, Waist-Hip ratio, Waist-Height ratio, body fat percentage using skinfold thickness.

METHODS

This case control study was conducted in the Department of Physiology, Index Medical College and Research Centre, Indore After approval from the institutional ethical committee informed and written consent was taken from all the participants of the study. A total of 72 male subjects in the age group of 36- 65 years comprising of 36 cases classified overweight and obese with higher than normal BMI, waist hip ratio , waist height ratio and body fat percentage and compared with 36 age matched controls. Normal healthy nonsmoker males aged 36-65 yrs, were taken as controls. Exclusion criteria for study subjcts include Smokers, known case of chronic renal disease, endocrine dysfunction and cases with any chronic respiratory illness or acute respiratory infection in last 1 year, people from athletic background and those Undergone a recent surgery, or having any contraindications for spirometry. 6 Cases with contraindications for pulmonary function testing were excluded. Hence total number of study subjects that proceed to spirometry was 60.

Minimum age for cases and controls was 37 and maximum age was 64. Mean age of study subjects was 47.5(±6.9) for cases and controls. For BMI Height was taken in centimeters with subject barefoot, using Stadiometer. Height was calculated in meters and Body weight (in Kgs) was measured using the electronic weighing machine. BMI is obtained as Kgs/m2. The waist-hip ratio is calculated as waist measurement divided by hip measurement. Waist circumference will be measured by placing the measuring tape midway between top of hip bone and the bottom of ribs. Hip circumference will be measured around the maximum circumference of the buttocks by the non-stretchable measuring tape. According to WHO criteria(Mungreiphy NK, 2012), W-H ratio <0.90 was classified as normal whereas W-H ratio >0.90 as obese. Waist to Height Ratio is a measure of the distribution of body fat. It is calculated by dividing waist circumference (in cm) with the height (in cm) of the individual. Waist to height ratio of 0.5 is taken as a cutoff for central obesity in adults (Ashwell, 2005).

Large proportion of body fat just under the skin, being the most accessible, the method mostly used for assessing the subcutaneous fat is the measurement of skinfold thickness. Skinfolds were measured at the biceps, mid- triceps, subscapular and supra-iliac regions. Each skinfold was measured three times and reported as average of three measurements. The body fat percentage for that age is taken corresponding sum of skinfold measurements (WHO, 2011). For age groups taken in our study subjects, body fat percentage < 21% is considered as normal while Body fat percentage ≥21% is taken as increased body fat percentage. For evaluation of lung volumes, spirometry is done. It is used to aid diagnosis, assess functional impairment and monitor treatment or progression of respiratory diseases. Spirometric parameters of lung function can be affected by many sorts of variations, including technical variations, biological variations and clinical variations (Maiolo C, 2003). Differences in pulmonary function in normal people may be due to ethnic origin, age, height, sex , weight and socioeconomic status. Apart from this it is also affected by physical activity, environmental conditions, altitude, tobacco smoking, In the historic study, John Hutchinson (the inventor of the spirometer) found that age and height are the most important determinants of lung function (Vijayan VK, 1990). The majority of equations used for the estimation of normal values of pulmonary function consider simple anthropometric parameters such as age, gender and height for prediction. Beyond gender, height and age, there are a lot of other anthropometric measurements that can influence the lung function. For evaluation of dynamic lung volumes spirometer was used with model RMS Helios 401 PC based spirometer with Indian predicted equations, ethnic corrections and easy to disinfect Detachable digital turbine transducer. At least three maneuver were performed after required rest and best maneuver were selected automatically by software. Forced Vital Capacity is the volume of air exhaled with maximum effort following a maximum deep inspiration. In this procedure, after deep inspiration, the patient is asked to blow out the air as hard and as fast he can; the spirometer. At least three efforts were taken and best maneuver was auto selected. FVC procedure includes inhalation and exhalation for at least six seconds.

Statistical analysis: The data was compiled and analyzed using appropriate statistical methods using Microsoft Excel and SPSS version 27. Percentage, mean, standard deviation and range were used to summarize the descriptive statistics. For correlation between anthropometric parameters and FVC, Karl Pearson Correlation test was performed. The P value < 0.05 was taken as statistically significant.

RESULTS

This case control study was conducted in the Department of Physiology, Index Medical College and Research Centre, Indore After approval from the institutional ethical committee informed and written consent was taken from all the participants of the study. A total of 72 male subjects in the age group of 36- 65 years comprising of 36 cases classified overweight and obese with higher than normal BMI, waist hip ratio , waist height ratio and body fat percentage and compared with 36 age matched controls. Normal healthy nonsmoker males aged 36-65 yrs, were taken as controls. Exclusion criteria for study subjects include Smokers, known case of chronic renal disease, endocrine dysfunction and cases with

Table 1. Correlation of various obesity indices with FVC (Cases)

Parameters	Mean	Std. Deviation	N	Karl Pearson coefficient of correlation (r)	P Value
BMI	29.63	2.141	30	-0.486	<.007*
FVC	3.4630	0.56094			
WHRatio	0.9020	0.03643	30	-0.03	0.876
FVC	3.4630	0.56094			
WhtRatio	0.5370	0.04284	30	0.082	0.668
FVC	3.4630	0.56094			
Bodyfat	22.5880	1.90635	30	-0.64	<.001*
FVC	3.4630	0.56094			

Table 2. Correlation of various obesity indices with FVC (Controls)

Parameters	Mean	Std. Deviation	N	Karl Pearson coefficient of correlation (r)	P Value
BMI	23.40	2.554	30	.367*	0.04
FVC	3.52667	0.376273			
WHRatio	0.8753	0.03521	30	0.055	0.772
FVC	3.52667	0.376273			
WhtRatio	0.5157	0.04116	30	-0.105	0.577
FVC	3.52667	0.376273			
Bodyfat	19.1730	1.64312	30	0.327	0.07
FVC	3.52667	0.376273			

any chronic respiratory illness or acute respiratory infection in last 1 year, people from athletic background and those Undergone a recent surgery, or having any contraindications for spirometry. . 6 Cases with contraindications for pulmonary function testing were excluded. Hence total number of study subjects that proceed to spirometry was 60. Minimum age for cases and controls was 37 and maximum age was 64. Mean age of study subjects was 47.5(±6.9) for cases and controls. Table 1 shows the Karl Pearson Correlation between Obesity parameters and FVC for cases. Obesity parameters taken were BMI, Waist Hip Ratio, Waist Height Ratio and Body Fat Percentage. BMI was found to be negatively correlated with FVC. The negative correlation of BMI with FVC was found to be statistically significant (P= 0.007). Among controls, the BMI was found to be positively correlated with FVC and this correlation was statistically significant (P=0.04). Table 2 shows Karl Pearson correlation coefficient r value positive and increased among controls. For waist hip ratio in cases, a negative correlation was found between waist hip ratio and FVC in cases but this was statistically insignificant (P>0.05). Among controls, a positive correlation was found between increased waist hip ratio and FVC but this was statistically insignificant (P>0.05). Among cases, a positive correlation between increase in waist height ratio and FVC was found, which was found to be statistically insignificant (P>0.05). Among controls, a negative correlation was observed between increased waist height ratio and FVC but this was statistically non-significant (P>0.05). For Body Fat percentage, a negative correlation was found between increased body fat percentage and FVC among cases. This negative correlation between body fat percentage and FVC among cases was found to be statistically significant (P<0.001). Among controls, a positive correlation was observed between increased body fat percentage and FVC. This positive correlation was statistically insignificant (P=0.07).

DISCUSSION

We have evaluated correlation of various obesity parameters including BMI, Waist Hip Ratio, Waist Height Ratio and Body Fat Percentage with FVC in our study subjects comprising cases and controls numbering 60. BMI was found to be negatively correlated with FVC. Increase in BMI reduces the FVC. The negative correlation of BMI with FVC was found to be statistically significant (P= 0.007). Compared to this in controls, the BMI was found to be positively correlated with FVC and this correlation was statistically significant (P=0.04). Table 2 shows Karl Pearson correlation coefficient r value positive and increased among controls. Considering the Mean BMI of cases which at 29.63 (±2.14) was significantly higher than mean BMI of controls at 23.40 (±2.56). Increasing the BMI within normal range leads to increase in FVC indicating BMI is an indicator for body built, this is why it has shown a positive correlation with FVC among controls. While increasing the BMI >25 kg/m2 leads to decrease in FVC especially in obese, similarly the correlation of BMI with FVC among cases was negative with cases mean BMI at 29.63 (±2.14). A study in UK population of 144 males aged 38-77 years observed that ERV and FRC were reduced in mildly obese males awaiting coronary artery bypass graft CABG surgery. An increase in intra-abdominal adipose tissue is associated with cardiovascular disease. it also interferes with the mechanical properties of the chest wall causing a decrease in compliance and preventing full excursion of the diaphragm. This mechanism is thought to account for the low FRC in obese subjects, In agreement with other studies of obese subjects the ERV was the lung volume most dramatically reduced and no consistent changes in the residual volume occurred (Jones RL, 2006). Effect of chest and abdominal adipose tissue on dynamic lung volumes requires further evaluation. Studies have established that deposition of fat in the thoracic-abdominal region is one of the main causes of the observed reduction in ERV. It is noteworthy that marked reductions in ERV may lead to abnormalities in ventilation distribution, with closure of airways in the dependent zones of the lung and inequalities in the ventilation-perfusion ratio (Mafort TT, 2012). Among cases, a positive correlation between increase in waist height ratio and FVC was found, which was found to be statistically insignificant (P>0.05). Among controls, a negative correlation was observed between increased waist height ratio and FVC but this was statistically non-significant (P>0.05). For Body Fat percentage, a negative correlation was found between increased body fat percentage and FVC among cases.

This negative correlation between body fat percentage and FVC among cases was found to be statistically significant (P<0.001).Among controls, a positive correlation was observed between increased body fat percentage and FVC. This positive correlation was statistically insignificant (P=0.07). Increase in body fat leads to decrease in FVC. Mean body fat percentage among cases was 22.6 (±1.91).

Controls had mean body fat percentage of 19.17(±1.64). Jones and Nzekwu reported that decreases in ERV, FRC, and TLC seem to exhibit an exponential correlation with increased BMI and are directly correlated with the mechanical effects produced by fat deposition in the chest and abdomen. According to this study, obesity decreases respiratory system compliance and creates mechanical restraints on the muscles responsible for breathing (Leone N, 2009). Body Fat Percentage<20% is denotes a healthy body composition, thus body fat within normal limits does not impact lung function significantly but increased body fat percentage indicates increased subcutaneous fat which is usually associated with central obesity. Increased subcutaneous fat in abdomen reduces descent of diaphragm and reduces FVC-in, thus producing a restrictive pattern. Childhood obesity is associated with a supra-normal or higher FEV1 and FVC, and a lower FEV1/FVC ratio, even after adjusting for height (Jones RL, 2006). This unexpected increase in FEV1 and FVC in obese children is due to airway dysanapsis, an incongruence between growth of the lung tissue and airway caliber (Forno E, 2017). Another study by Dixon AE *et al* in adults,(Dixon AE, 2006) found that Obese asthmatics had slightly decreased FEV1 and forced vital capacity (FVC) compared to normal weight asthmatics. These Obese subjects had significantly higher indices of sleep disturbance. Increased abdominal obesity has been linked to increased airway closure in the para-diaphragmatic lung regions and this impaired cranio-caudal distribution of inspired gas, especially in the supine position(Engel LA, 1981).

CONCLUSION

Increases in BMI within normal range leads to increase FVC indicating better body built with increased height and weight increases the FVC while further increases in BMI in overweight and obese range leads to reduction in FVC. Similarly body fat percentage within healthy range does not impact lung function significantly but increases body fat percentage leads to reduction in FVC.

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Keywords: Pulmonary Function Testing, Forced Vital Capacity, Obesity, Anthropometric measurements

Abbriviations

BMI Body Mass Index
FVC Forced vital capacity
PFT Pulmonary Function tests

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