



## Original Research Article

## Body fat distribution and its effect on vital capacity index in young adults

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## ABSTRACT

**Aims:** To study the effect of body compositions such as BMI, waist hip ratio, body fat composition on lung function and also to correlate any changes with gender difference.

**Materials and Methods:** A total of 164 medical students aged 18-23 years were taken into study. Height, weight, waist hip ratio (WtHR), Body Mass Index (BMI), were recorded. Body fat composition was analysed using Omron Karada scan – body composition monitor model HBF- 375. Vital capacity was estimated using spirometer. Data was analyzed statistically by using SPSS 20.0 software.

**Results:** Lung function assessed as vital capacity index (VCI) was negatively correlated ( $r < 0; p < 0.05$ ) with VAT, SAT, BMI, WtHR, BFP for both male and females. Body anthropometric measurements like waist to hip ratio (WtHR), BMI and lung function tests like vital capacity index (VCI) are more in males. Where as females have higher body fat percentage (BFP). and Subcutaneous adipose tissue (ScAT). There was no much significant difference in Intra abdominal adipose tissue (IAAT) in males and females.

**Conclusion:** There was an inverse correlation between lung function with fat accumulation in the body.

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### 1. Introduction

Obesity has been increasing in prevalence and is a predisposing factor for many illnesses like cardiovascular disease, type 2 diabetes, hypercholesterolemia, asthma and cancer.<sup>1</sup> Excessive abdominal fat distribution has been associated with higher levels of total cholesterol, serum triglycerides and low density lipoproteins (atherogenic lipoprotein profile) which in turn contribute to further cardiovascular risk.<sup>2</sup> Body fat of men will be distributed mainly abdominal when compared to women of reproductive age group.<sup>3</sup> Breathing is vital for survival, and any changes in respiratory function will have an effect on performance of regular activities. Past studies have shown that fat is related to impaired metabolism, along with reduction in pulmonary volumes such as total lung capacity and vital capacity.<sup>4</sup> Obesity is a possible risk factor for exercise intolerance, and also for the development of COPD.

Body mass index (BMI, calculated as weight in kilograms divided by height in meter square) greater than

24 are considered as overweight, BMI > 28 considered as obese has been negatively related to lung functions such as forced expiratory volume in first second (FEV1), and forced vital capacity (FVC). Increased anthropometric parameters like waist circumference (WtC), waist-to-hip ratio (WtHR), and also total body fat percentage (BFP) which indicates body proportion are inversely correlated with impaired lung functions.<sup>5</sup> The accumulation of abdominal fat is determined mainly by IAAT deposition and to a lesser extent by ScAT. Compared with ScAT, IAAT is believed to be more important in developing the insulin resistance, lipid abnormalities, and inflammation.<sup>6</sup>

Men aged between 50 -70 years with metabolic syndrome shows an inverse correlation between visceral fat, BMI, WC with FEV1, and FVC.<sup>7</sup> In previous studies the correlations between VCI and Body fat distribution were analysed in either people above 50 years or people with metabolic syndrome. Whether these correlations apply to the healthy adults is to be assessed by this study. In the current study, we included 164 medical students to analyze the associations between fat distribution and lung functions as there are less chances of age related changes and metabolic

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syndromes. The BMI, BFP, WtHR, IA AT, ScAT, and vital capacity index (VCI, taken as a standard for lung function) were measured. We analyzed the association between lung function and IA AT, ScAT, BMI, BFP, and WtHR in young adults. These correlations were also analyzed individually between males and females to know the gender differences in fat distribution that affect the lung function.

## 2. Materials and Methods

A total of 164 medical students of GSL Medical college, aged 18-23 in which 93 were females and 71 were males were taken into study. The study was explained and informed consent was taken from individual participant. Participants with respiratory, cardiovascular diseases and previous history of anti tuberculosis medication, smoking history, any history of chest trauma and major surgeries were excluded from the study. Weight and height of the individuals were taken where the individual is having light weight clothing and with no foot wear. Height was measured in centimetres by height chart and weight in kg by using digital weighing machine. Waist-to-hip ratio, is the ratio of circumference of the waist to circumference of the hips. Waist circumference was measured by taking the mid point between lowest palpable rib and top of iliac crest (approximately at the point of umbilicus) while the Hip measurement is at the widest part of buttocks with measuring tape. BMI was calculated as weight divided by square of height in meters ( $\text{Kg}/\text{m}^2$ ).

Body fat compositions were measured using Omron Karada scan – body composition monitor model HBF-375. This device uses biochemical impedance to estimate fat percentage. Depending on where fat is accumulated it is divided into Intra abdominal adipose tissue (IAAT) and Subcutaneous adipose tissue (ScAT). Vital capacity was estimated using alpha vitalograph spirometer. The students were instructed to have 3 to 4 normal tidal breathes and then deep inspiration and slow expiration as long as they can. Three readings were taken and the maximum reading is taken as final reading. As vital capacity is affected by posture all the recordings were taken in standing position with neck slightly extended. Vital capacity is also influenced by height and weight of the individual vital capacity is converted into vital capacity index by dividing vital capacity with body weight in Kilograms ( $\text{ml}/\text{kg}$ ).

Results were presented as mean + Standard Deviation. Statistical analysis was performed using the SPSS version 20.0 software. Analysis of variance (ANOVA) was used to assess the statistical significance,  $P < 0.05$  was taken as statistically significant the correlation between VCI and Body fat indices was done by Pearson's correlation correlation relation factor  $r$  is calculated and is analysed as  $r < 0$  is negatively correlated,  $r=0$  is nil significant  $r > 0$  positive correlation.

## 3. Results

A total 164 students were taken into study. Their age, body compositions and vital capacity index are tabulated as mean and standard deviations in Table 1

As revealed from Table 1 male participants showed significantly higher BMI, WtHR, VCI, compared with females. Female participants showed relatively more BFP, ScAT than males. There was no significant difference in IAAT between females and males.

Correlation of body indices and vital capacity index for both males and females were done using Pearson's correlation.  $r$  value and  $p$  value were calculated.

As evident from table 2 males body indices such as BFP, IA AT, ScAT, BMI, WtHR showed negative correlation with VCI ( $r < 0$ ,  $P < 0.01$ ). Females showed similar result as men.

## 4. Discussion

In the present study 164 medical students were recruited to study the effects of abdominal fat distribution on lung function. We found that abdominal fat parameters such as BFP, IAAT, ScAT are negatively correlated with Vital capacity index in both males and females. Abdominal fat distribution has been associated with type 2 diabetes, coronary heart disease, irritable syndrome and also impaired lung functions. In a similar study IAAT, BMI, Waist circumference are inversely associated with impaired lung function in men aged 50-70 years with the metabolic syndrome.<sup>7</sup> In another study by Capelo AV et al<sup>8</sup> lung functions were inversely associated with visceral adiposity in females of mean age 55.39 years with Bronchial asthma.

The above cited two studies have their limitations as the subjects were aged more than 50 may be having metabolic syndrome or age related impairment of lung function. So it is unclear with these studies whether there is direct correlation between visceral adipose tissue and lung functions. So to avoid the age related and metabolic syndrome related confusion, we recruited young adults to know the correlation between visceral adipose tissue and lung function. College students of aged eighteen to twenty three years were believed to be matured enough physically and psychologically. Thus college student subjects who falls under young age and with no much age related changes and metabolic syndromes might enhance the validity of the analysis.

There are two ways of estimating body fat composition, one is Dual energy X-ray absorptometry (DXA) and the other one is bioelectric impedance analysis (BIA). Out of the two methods DXA is the gold standard for estimating body fat indices.<sup>9</sup> However Bioelectric impedance is taken here for analysing the body fat composition because of the following reasons. DXA has a risk of radiation exposure which may psychologically manipulate the subjects willing to participate in the study. DXA is costlier and is not

**Table 1:** Body compositions and vital index in the participants

Parameter	Total(164)	Men (71)	Women(93)	P value
Age (years)	19.90 + 1.467	20.01 + 1.492	19.88 + 1.465	0.577
Height (cm)	160.97 + 7.30	169.02 + 5.882	157.71 + 4.896	0.000*
Weight (kg)	51.34 + 8.256	58.76 + 8.877	48.31 + 5.723	0.000*
BMI	19.73 + 2.302	20.52 + 2.655	19.43 + 2.067	0.003*
WtHR	0.81 + 0.043	0.87 + 0.367	0.77 + 0.247	0.038*
BFP (%)	20.44 + 7.036	12.89 + 5.534	23.54 + 4.916	0.000*
ScAT(kg)	9.71 + 3.795	7.05 + 3.835	10.76 + 3.212	0.000*
IAAT(kg)	0.84 + 0.619	0.86 + 0.857	0.81 + 0.485	0.637
VCI(ml/kg)	55.88 + 11.497	62.81 + 11.613	53.07 + 10.173	0.000*

BMI- Body Mass Index, WtHR -Waist Hip Ratio, BFP-Body Fat percentage, ScAT-subcutaneous adipose tissue, IAAT-Intra abdominal adipose tissue, VCI-Vital Capacity index

\*P<0.05 is statistically significant

**Table 2:** Pearson's correlation analysis between body composition indices and vital capacity index

Parameter	Men		Women	
	r value	p value	r value	p value
BFP	-0.384	<0.01*	-0.332	<0.01*
IAAT	-0.465	<0.01*	-0.325	<0.01*
ScAT	-0.413	<0.01*	-0.354	<0.01*
BMI	-0.453	<0.01*	-0.332	<0.01*
WtHR	-0.376	<0.01*	-0.335	<0.01*

BFP-Body Fat percentage, IAAT-Intra abdominal adipose tissue, ScAT-subcutaneous adipose tissue, , BMI- Body Mass Index, WtHR-Waist Hip Ratio.

\*p<0.05 is statistically significant, r<0 negatively correlated

feasible for such a number of participants. Bioelectric impedance is easy and no radiation exposure, cheaper, expertise technician need not be required for the analysis. In a study done by Najate A et al. concluded that DXA and BIA can be used interchangeably at population level.<sup>10</sup>

Fat distribution varies with gender, women are typically having more SAT, where as men are having additional VAT,<sup>11</sup> which is also in according to our study, though there was additional IAAT in men however it's not statistically significant. The variations in body fat composition of men and women may be mainly due to hormonal and life style changes. For example oestrogen in females will increase the deposition of more ScAT than IAAT.<sup>12</sup> Central obesity which leads to visceral fat accumulation in thorax and abdomen have a tendency to reduce the movements of diaphragm and chest cavity, while peripheral obesity have relatively low effect.<sup>13</sup> Not only fat distribution of both the genders but also difference in lung morphology and hormones also effect the lung function.<sup>14</sup> In the current study VCI is inversely correlated with BFP, IAAT, ScAT in each the genders, however VCI is more negatively correlated with IAAT in males and ScAT in females, suggesting a gender difference in fat distribution and its impact on lung functions confirming our hypothesis.<sup>15,16</sup> contrary to our study park et al. Study have shown IA AT has shown more negative correlation than SAT in females of mean age group 53.4 years.<sup>17</sup> Probabilities for this contradiction may be the age taken in their study was

almost post menopausal which may lead to accumulation of visceral fat.

In this study not only IAAT, ScAT, we also studied the correlation between BFP, WtHR, BMI and VCI which is also inversely correlated. Increase in BMI, BFP, WtHR has been associated with the accumulation of excessive fat within the abdominal cavity and on chest wall. This accumulation of fat in the abdominal cavity and on the chest wall restricts the movements of diaphragm as well as chest wall which can lead to the decrease in Vital capacity, decreasing the pulmonary volumes, increasing the work of respiratory muscles, and eventually affecting the gaseous exchange.<sup>18</sup> In the present study there is also gender variations in WtHR, BMI, VCI relatively more in males except BFP which was more in women.

The study has some limitations like only VCI was taken, FVC, FEV1, FEV1/FVC were not taken because of the complexity. Another limitation is its a cross-sectional study which lacks the analysis about the other probable causes for the alteration of lung functions.

## 5. Conclusion

The above done study has showed significant inverse correlation between abdominal fat distribution and vital capacity index in young adults of both genders. IAAT is more negatively associated with VCI in males, where as ScAT in females.

## 6. Source of funding

None.

## 7. Conflict of interest

None.

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