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Original Article

PHYSIOTHERAPEUTIC STUDY ANALYZING THE RELATIONSHIP BETWEEN BODY COMPOSITION AND LUNG FUNCTION

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ABSTRACT

Background: Influence of body composition on lung functions is of enormous clinical importance. Impaired lung functions particularly low forced vital capacity (FVC), low forced expiratory volume in 1 s (FEV1) and FVC & FEV1 ratio are associated with increased morbidity and mortality, and it is also well recognized that severe clinical obesity is associated with impairment of lung function. The aim of our study is to observe the correlation between pulmonary function and body composition parameters on individuals with different body mass index.

Methods: 150 subjects consist of 75 males and 75 females in the age group of 40 to 60 years, were classified into normal weight, overweight and obese grade 1 groups according to the WHO guidelines. The body composition measured by using the Bioelectric Impedance based Tanita BC-418 and pulmonary functions assessed by using computerized Jaeger Master scope.

Results: Results of statistical analysis showed that the fat free mass of normal male was identified as the strongly significant predictor of variation in pulmonary function parameters such as FVC ($p<0.006$) and FEV 1s ($p<0.008$) in comparison to normal female ($p>0.05$). The BMI ($p<0.002$) and FFM ($p<0.001$) detected as strongly significant while TF% ($p<0.05$) identified as significant predictor of variation in FVC of the obese grade 1 male (Group C). It was also found that the BMI ($p<0.001$), TF% ($p<0.004$) and FFM ($p<0.001$) of obese grade 1 male strongly impacted the FEV 1s. The ratio (FVC/FEV 1s) was less significantly ($p>0.05$) by BMI FFM and TF% of obese grade 1 male.

Conclusion: A significant positive correlation was observed between fat free mass and FCV and FEV1. Body fat percentage and trunk fat percentage had a stronger correlation than BMI.

KEY WORDS: Forced vital capacity, Forced expiratory volume in 1sec, Body mass index, Body fat percentage, Trunk fat percentage, Fat free mass.

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INTRODUCTION

Obese people are at increased risk of respiratory symptoms, such as breathlessness, particularly during exercise, even if they have no obvious respiratory illness and severe clinical obesity is associated with impairment of lung function

[1,2]. Among the different systems affected by obesity, the respiratory system deserves special attention, as obesity can cause changes in respiratory function, exercise tolerance, pulmonary gas exchange, respiratory pattern, and strength and endurance of the respiratory muscles [3]. Weight gain is accompanied by a decrease in forced vital capacity (FVC) and forced expiratory volume in one sec (FEV1), and reduction of body weight leads to significant improvement in pulmonary function [4-6]. Several studies have shown age related changes in body composition. With advancing age, elderly men and women tend to become more obese; their amount of visceral fat tends to increase, and their skeletal muscle mass declines. (7-12) Lung function also declines with age [13]. Age-related changes in pulmonary function are clinically relevant because impaired lung function is associated with increased mortality rates [14]. It was reported that respiratory muscle strength and lung function are closely associated with body weight and lean body mass in patients with chronic obstructive pulmonary disease (COPD) [15] and that a central pattern of fat distribution is negatively associated with lung function in healthy adults [16-17], with excess weight on the anterior chest wall due to obesity lower chest wall compliance and respiratory muscle endurance with increase n work of breathing and airway resistance [18-20].

Body Composition and Pulmonary Functions: Obesity is characterized by a stiffening of the total respiratory system [21], which is presumed to be due to a combination of effects on lung and chest wall compliance [22]. Abdominal and thoracic fat are likely to have direct effects on the downward movement of the diaphragm and on chest wall properties, while fat on the hips and thighs would be unlikely to have any direct mechanical effect on the lungs [23].

Most studies have demonstrated a reduction in lung compliance in obese individuals [24-26] that appears to be exponentially related to BMI (25). Reductions in lung compliance may be the result of increased pulmonary blood volume, closure of dependent airways, resulting in small areas of atelectasis [24], or increased alveolar surface tension due to the reduction in FRC.

Studies that examined the relation between obesity and lung function used body mass index (BMI) as a measure of overall adiposity, and non-significant or weak associations have been reported, with diminished lung function at both extremes of the BMI distribution (i.e. thin or obese) [27,28]. However, BMI does not take into account the pattern of fat distribution or body composition and cannot adequately distinguish between fat mass (FM) and fat-free (i.e., lean) mass (FFM). In the past few years, it was suggested that these factors might have distinct effects on pulmonary function [29-32].

MATERIALS AND METHODS

A comparative observational study with a total of 150 subjects, age group between 40-60 years (Males and Females), with Normal BMI, over weighted males and females and obese males and females were taken for study, also excluded the subjects above 60 years and below 40 years of age, with any illness or disease like any cardiovascular, pulmonary diseases like COPD, asthma, smokers and alcoholics, with any past surgical or long-term medical history.

Obtained data was divided into the 6 subgroups, each sub-group having 25 subjects. Data obtained from the health check up conducted in Bombay hospital, Indore, in which the individual undergone the investigation of body composition analysis and pulmonary functions test.

In this study we divided between male and female groups. Further this group divided into 3 subgroups according to their BMI.

For male group subgroups are:

1. Group A-normal males (19-25)
2. Group B-overweight males (25-30)
3. Group C-obese grade 1 males (30-34)

For female group subgroups are

1. Group A1-normal females (19-25)
2. Group B1-overwieght females (25-30)
3. Group C1-obese grade 1 females (30-34)

Procedure: Measurement of pulmonary function parameters: - All the subjects underwent annual health checkup in our hospital. They performed pulmonary function test by computerized PFT machine Jaeger Masterscope. We collected PFT reports of the subjects by the

PFT department according to our inclusion criteria.

This modality calculate the body composition parameters including BMI, Total body fat %, Trunk fat %, total body water, lean body mass and segmental analysis of body fat. Segmental reading separates into fat % mass, fat free mass and predicted muscles mass for: Right Arm, Right Leg, Left Arm, Left Leg and Trunk.

Outcome measures used for this study includes FVC (forced vital capacity), FEV1s, Total body fat percentage, Trunk fat percentage, Lean body mass, BMI (body mass index)

RESULTS

The mean difference isn't significant (insignificant) at the 0.05 level of significance. Body composition parameters showed statistical significance either in male or female groups are only depicted.

Multivariate analysis is used to determine the significance of prediction of variation in pulmonary function parameters such as Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV 1s) and ratio (FVC/FEV 1s) with reference to variation in body composition parameters such as Body Mass Index (BMI), Trunk fat percentage (TF%), Total Body Fat Percent (TBF%), Fat Free Mass (FFM). The model is based on body composition parameters and so designed (Intercept +BMI+TBF+TFP+FFM) that the significance of variation in pulmonary function parameters that used as dependent variables may be assessed. The Body composition parameters, which showed statistical significance either in male or female groups, only considered for presentation in the table1.

It is easily seen by used tests of between-subjects effects in the table1 that fat free mass of male (Group A) subjects whose body mass index was normal identified as the strongly significant predictor of variation in pulmonary function parameters such as FVC ($p<0.006$) and FEV 1s ($p<0.008$) in comparison to normal female (Group A1) whom predicted variation was statistically insignificant ($p>0.05$) in pulmonary function parameters.

The mean difference isn't significant (insignificant) at the 0.05 level of significance. #Body composition parameters showed statistical significance either in male or female groups are only depicted.

Table 1: Multivariate analysis for the assessment of variation in body composition parameter affecting pulmonary function parameters.

Group	Source	Dependent Variable	Tests of Between-Subjects Effects#		LOS p-value
			Mean Squares	F	
(Group A & A1)	FFM (Male)	FVC	3.49	9.34	p<0.006 *
		FEV 1s	1.784	8.81	p<0.008 *
		FEV1s/FVC	0.001	0.07	p>0.05 ⊗
	FFM (Female)	FVC	0.002	0.02	p>0.05 ⊗
		FEV 1s	0.013	0.16	p>0.05 ⊗
		FEV1s/FVC	0.001	0.24	p>0.05 ⊗

* The mean difference is highly significant at the 0.001 level of significance.

Multivariate analysis is used to determine the significance of prediction of variation in pulmonary function parameters with reference to variation in body composition parameters and the server model is described in earlier table. The body composition parameters, which showed statistical significance either in male or female groups, only considered for presentation in the table 2.

Table 2: Multivariate analysis for the assessment of variation in body composition parameter affecting pulmonary function parameters.

Group	Source	Dependent Variable	Tests of Between-Subjects Effects#		LOS p-value
			Mean Squares	F	
Overweight (Group B & B1)	FFM (Male)	FVC	0.712	3.49	p<0.08
		FEV 1s	0.525	3.13	p<0.09 +
		FEV1s/FVC	0.001	0.39	p>0.05 ⊗
	FFM (Female)	FVC	2.075	3.9	p<0.06 +
		FEV 1s	0.434	1.45	p>0.05 ⊗
		FEV1s/FVC	0.05	8.63	p<0.008 *

+ The mean difference is suggestively/poorly significant at the 0.09, 0.07 0.06 level (91.0%, 93.0% and 94.0% Confidence Levels). * The mean difference is highly significant at the 0.001 level of significance.

The table 2 revealed that the fat free mass of overweight male (Group B) detected as poorly significant predictor of variation in pulmonary function parameters such as FVC (p<0.08) and FEV 1s (p<0.09) may be due to chance in comparison to overweight female (Group B1) whom predicted variation was also poorly significant (p<0.06) on statistical ground for FVC.

The fat free mass in female overweight (Group B1) was predicted the ratio (FVC/FEV 1s) strongly which confirmed highly significant (p<0.008) in comparison to overweight (Group B) male who were observed with insignificant (p>0.05) variation for ratio.

Table 3: Multivariate analysis for the assessment of variation in body composition parameter affecting pulmonary function parameters.

Group	Source	Dependent Variable	Tests of Between-Subjects Effects#		LOS p-value
			Mean Squares	F	
Obese Male (Group C)	BMI (Male)	FVC	1.422	12.49	p<0.002*
		FEV 1s	1.73	18.27	p<0.001*
		FEV1s/FVC	0.01	1.75	p>0.05⊗
	TF % (Male)	FVC	0.585	5.13	p<0.05*
		FEV 1s	0.98	10.34	p<0.004*
		FEV1s/FVC	0.011	1.96	p>0.05⊗
	FFM (Male)	FVC	3.29	28.9	p<0.001*
		FEV 1s	2.723	28.75	p<0.001*
		FEV1s/FVC	0.004	0.75	p>0.05⊗
Obese female (Group C1)	FFM (Female)	FVC	0.971	3.79	p<0.07+
		FEV 1s	0.247	1.34	p>0.05⊗
		FEV1s/FVC	0.027	4.39	p<0.05*

+ The mean difference is suggestively/poorly significant at the 0.07 level (93.0% Confidence Level). * The mean difference is highly significant at the 0.004, 0.002 and 0.001 level of significance. The mean difference isn't significant (insignificant) at the 0.05 level of significance. #Body composition parameters showed statistical significance either in male or female groups are depicted.

The body composition parameters, which showed statistical significance either in male or female groups, only considered for presentation in the table 3. Multivariate analysis is used to determine the significance of prediction of variation in pulmonary function parameters with reference to variation in body composition parameters and the server model is described in earlier table. It is clearly seen in the table 3 that BMI, TF % and FFM are the various body composition parameters strongly influencing the pulmonary function parameters in obese grade 1 male (Group C) in comparison to obese grade 1 female whom FFM is the only factor.

The BMI (p<0.002) and FFM (p<0.001) detected as strongly significant while TF% (p<0.05) identified as significant predictor of variation in FVC of the obese grade 1 male (Group C). It was also found that the BMI (p<0.001), TF% (p<0.004) and FFM (p<0.001) of obese grade 1 male strongly impacted the FEV 1s.The fat free mass in obese grade 1 female (Group C) influenced FVC (p<0.07) poorly but the ratio (FVC/FEV 1s) influenced significantly (p<0.05). The fat free mass in female obese grade 1 (Group C1) predicted the ratio (FVC/FEV 1s) significantly confirmed statistically (p<0.05) in comparison to male who were observed with insignificant (p>0.05) value.

Moreover, it is concluded that there was a significant mean difference in body composition parameters such as BMI, Total Body Fat %, TBF %, TF % and FFM with respect to pulmonary function such as FVC, FEV 1s along with ratio (FEV 1s/FVC) among normal, overweight and obese grade 1 male and female which influenced that selected male and female had different body composition parameters with reference to their pulmonary function. Moreover, it was confirmed that there was a relationship between parameters of body composition and pulmonary functions.

Therefore, all the tables highlighted the comparisons between male and female groups sorted according to category of BMI had variation in pulmonary functions that evidenced better significant predictors of different body composition parameters in obese grade 1 male in comparison to obese grade 1 female. The pulmonary functions of normal and overweight male and female was predicted fat free mass as the significant predictor among all selected body composition parameters.

DISCUSSION

As per the various researches conducted in the field of cardiopulmonary fitness and its relative implication on obesity and vice versa we, hereby discuss the findings in our study by putting forward certain observation in which it is shown that obese people are at increased risk of respiratory symptoms, such as breathlessness, particularly during exercise, even if they have no obvious respiratory illness and severe clinical obesity is associated with impairment of lung function [1,2]. The aim of our study was to create awareness and establish the importance of early preventive analysis of, body composition parameters and pulmonary function parameters among individual in general community with differences in body mass index. Thus our study emphasized the importance of body composition analysis in preventing hazards of obesity and establishing pulmonary fitness for facilitating general well being in our community. We correlated BCA parameters such as BMI, Total body fat percentage, Trunk fat percentage, and lean body mass with PFT parameters such as FVC, FEV1sec and FEV1/FVC ratio. Multivariate analysis is used to determine the significance of prediction of variation in pulmonary function parameters with reference to variation in body composition parameters. In table1, the fat free mass of male (Group A) was identified as the strongly significant predictor of variation in pulmonary function parameters such as FVC ($p<0.006$) and FEV 1s ($p<0.008$) in comparison to normal female (Group A1) whom predicted variation was statistically less significant ($p>0.05$) in pulmonary function parameters. The fat free mass in female overweight (Group B1) was predicted the ratio (FVC/FEV 1s) strongly which confirmed highly significant ($p<0.008$) in comparison to overweight (Group B) male who were observed with less significant ($p>0.05$) variation for ratio.

The BMI ($p<0.002$) and FFM ($p<0.001$) detected as strongly significant while TF% ($p<0.05$) identified as significant predictor of variation in FVC of the obese grade 1 male (Group C). It was also found that the BMI ($p<0.001$), TF% ($p<0.004$) and FFM ($p<0.001$) of obese grade 1 male strongly impacted the FEV 1s. The ratio (FVC/FEV 1s) was less significantly ($p>0.05$) by BMI FFM and TF% of obese grade 1 male.

The fat free mass in obese grade 1 female (Group C) influenced FVC ($p<0.07$) poorly but the ratio (FVC/FEV 1s) influenced significantly ($p<0.05$). The fat free mass in female obese grade 1 (Group C1) predicted the ratio (FVC/FEV 1s) significantly confirmed statistically ($p<0.05$) in comparison to male who were observed with I less significant ($p>0.05$) value. Thus, the study evaluated a relationship between parameters of body composition and pulmonary functions and therefore awareness among individuals regarding pulmonary fitness and maintaining ideal body composition may be created.

CONCLUSION

BMI and body fat percentage were negatively correlated with FVC and FEV1 in males and females of the overweight group. The body fat percentage and trunk fat percentage had a stronger correlation than BMI, thus suggesting that body fat percentage was a major determinant of the reduced pulmonary functions in overweight and obese grade 1 than in BMI. The fat free mass was positive correlated with the pulmonary function parameter. Our findings also suggest that there is significant impairment of the pulmonary functions in the overweight and obese grade 1 groups' populations and that the possibility of small airway disease is higher in the overweight group and obese grade 1 group. Our study concluded that more trunk fat percentage impaired pulmonary function total body fat percentage, and individual with more fat free mass had the good pulmonary function.

Conflicts of interest: None

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