

Effect of gender and body composition on dynamic lung function tests in young Gujarati Indian population

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Abstract

Background: Fat-free mass (FFM) and fat mass (FM) are not necessarily similar in individuals within normal range of body mass index. Fat-free mass index (FFMI) and fat mass index (FMI) affect the dynamic lung functions in young Indians.

Objective: To check the relation of body composition with lung function in young Gujarati Indian population and learn if any gender difference exists in such relation.

Materials and Methods: A cross-sectional study was conducted on 102 male and 84 female subjects in the age group of 17–21 years. Body composition parameters such as FFM, FM, and total body fat% were measured by Omron HBF-302, a body fat monitor. Dynamic lung functions [forced expiratory volume in 1 s (FEV₁), forced expiratory volume at 6 s (FEV₆), FEV₁/FEV₆ and peak expiratory flow rate (PEFR)] were recorded using PiKo-6 and Wright's peak flow meters.

Result: FEV₁, FEV₆ and PEFR were significantly lower in female subjects when compared with male subjects. FMI showed a significant negative correlation with dynamic lung functions, while FFMI showed a significant positive correlation with dynamic lung functions. Body composition parameters such as FM and FFM (lean body mass) were associated with the dynamic lung functions in young Gujarati Indian students.

Conclusion: We may conclude that FFM and FM are significantly associated with the dynamic lung functions in young Gujarati Indian students in the age group of 17–21 years. FFM shows a positive correlation with lung functions, and FM shows a negative correlation with lung functions.

KEY WORDS: Body mass index, fat mass, fat free mass, FMI, FFMI, dynamic lung functions, Gujarati Indians

Introduction

Pulmonary function test (PFT) is one of the basic and essential tests to check the proper functioning of lungs. PFT is affected by age, gender, height, weight, and ethnicity.^[1,2] Lung function measurements are also affected by physical

fitness and environmental factors. Body composition plays a main role for the proper functioning of lungs in healthy individuals.^[2,3] Body composition parameters such as body mass index (BMI), fat mass index (FMI), and fat-free mass index (FFMI) and their association with pulmonary functions were documented by many researchers, since the previous years, with different results in both genders. Yet, the association of body composition with lung functions are not fully understood.

Body composition parameters such as fat mass (FM) and fat-free mass (FFM) are different in Indians with normal range of BMI.^[2,4] Nowadays, lean individuals with high FM are reported. Underweight individuals with high FM and overweight and obese individuals with low FFM are also documented by many authors. The strength and bulk of respirator muscle and lung functions were associated with body weight

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and FFM in normal healthy individuals.^[4-6] Gender-related body composition and FM distribution changes could be associated with impaired lung functions even in young individuals.

Physical inactivity and high FM in female subjects are the biggest risk factors for cardiorespiratory fitness and associated with impaired lung functions.^[7] In sedentary male subjects, reduced muscle mass is associated with impaired lung functions. Mortality owing to cardiorespiratory diseases is very common in male subjects owing to improper nutrition and lack of exercise.^[7] The aim of our study was to understand the relation of body composition with lung function in young healthy students and learn if any gender difference exists in such relation.

Materials and Methods

A cross-sectional study was conducted on 186 Gujarati Indians in the age group of 17–21 years, studying at a college in the vicinity, after taking the approval of Human Research Ethics Committee. The participants were informed about the nature of study, procedure, and usefulness of the study to our country. Informed consent was taken from each participant. All the participants were physically healthy and free from any disease or symptoms of disease. The participants with respiratory problems, undergoing treatment for any disease, and doing regular exercise of any type were excluded from the study.

Body Composition

The body composition was assessed in a light weight of clothing. The body weight was recorded in kilograms on an empty bladder and before lunch on a standard weighing machine. The body weight was recorded bare footed to the nearest 0.1 kg. The height was measured using meter scale without footwear to the nearest 0.1 cm. BMI was calculated as the weight (kg) divided by the square of height (m²). Total body fat percentage (TBF %) and FM were assessed by bioelectrical impedance technique using Omron HBF-302, a body fat monitor. FMI was calculated as the FM (kg) divided by the square of height (m²). FFM was calculated by deducting FM from the body weight, and FFMI was calculated as the FFM (kg) divided by the square of height (m²).^[2,7]

Dynamic Lung Functions

The forced expiratory volume in 1 s (FEV₁) and forced expiratory volume at 6 s (FEV₆) were recorded using PiKo-6 peak flow meter. The peak expiratory flow rate (PEFR) was recorded using Wright's peak flow meter. These tests were recorded at noon time before lunch, as expiratory flow rates are the highest at noon.^[8] All dynamic lung functions were recorded on the same day, in sitting position with head straight. All the tests were explained and demonstrated to each participant before beginning. For each participant, three readings were taken at full effort, and the best one was taken for the study, as per the guideline of the American Thoracic Society.^[9]

Statistical Analysis

The mean and standard deviation (SD) were calculated for the study variables. Student's unpaired *t*-test was used to determine if any significant differences ($P < 0.05$) existed in the body composition and dynamic lung functions between male and female subjects. Pearson's correlation coefficient was determined to study the correlation of body composition variables with dynamic lung functions.

Result

A comparison of body composition parameters and lung functions test parameters between male ($n = 102$) and female ($n = 84$) participants are shown in Table 1. Unpaired Student's *t*-test was done; we found statistically significant gender differences between the parameters except for age and BMI. In our study, the BMI was found within the normal range. FEV₁, FEV₆, and PEFR were significantly higher among male subjects when compared with female counterparts.

Table 2 shows the Pearson's correlation coefficient (*r*) between BMI, FMI, and FFMI with PFT in male and female subjects. In male subjects, a significant positive association of BMI and FFMI with PFT was seen. While in female subjects, a significant negative association of FMI with FEV₁ and FEV₆ was seen.

Discussion

This study reports the finding of association between the body composition parameters and lung functions based on gender differences in sedentary healthy young individuals in the age group of 17–21 years from Gujarat, India. Lung functions parameters such as FEV₁, FEV₆, and PEFR were less in female subjects when compared with male subjects. Our findings are supported by Behera *et al.*^[10] and Budhiraja *et al.*,^[11] who had reported lower lung functions in female subjects in similar age group. Lung functions are more in male subjects when compared with female subjects, because of their structural and physiological differences. Lung functions differences also exist mainly because of different sex hormones in male and female subjects. Male subjects are more muscular than female subjects.^[10,12] In male subjects, more muscle mass and bigger lungs when compared with female subjects are considered as contributing factors for good lung functions.^[10,12,13]

BMI that includes FM and FFM is the best tool to judge the nutritional status and overall health of individuals. Lung function shows a U-shaped relationship with BMI.^[2,14] Reduced lung functions are seen in underweight and overweight individuals when compared with normal weight individuals. It is supported by Thyagarajan *et al.*^[14] and Dockery *et al.*^[15] Association of lung functions with FM and FFM is the least documented in the community. In our study, a significant positive association was found between FFMI and FEV₁ and FEV₆, and PEFR. This is supported by Joshi *et al.*^[4] While a significant negative correlation was found between FMI and

Table 1: Comparison of body composition parameters and lung functions in male and female Gujarati Indian students of 17–21 years of age group

Parameters	Male students (n = 102)	Female students (n = 84)
Age (years)	18.8 ± 1.08	19.2 ± 0.96
Height (cm)	172.2 ± 6.95	156.64 ± 5.97**
Weight (kg)	59.13 ± 11.95	50.28 ± 8.46**
BMI (kg/m ²)	19.79 ± 3.3	20.41 ± 3.35
TBF%	15.86 ± 6.28	26.27 ± 6.34**
FM (kg)	10.12 ± 6.20	13.53 ± 5.59**
FMI (FM/height ²)	3.41 ± 2.09	5.52 ± 2.31**
FFM (kg)	49 ± 7.24	36.74 ± 3.74**
FFMI (FFM/height ²)	16.47 ± 1.85	14.97 ± 1.28**
PEFR (L/min)	527.35 ± 73.22	400.71 ± 53.47**
FEV ₁	2.51 ± 0.55	1.82 ± 0.46**
FEV ₆	2.91 ± 0.63	2.18 ± 0.56**

Values are given in mean ± SD, **P*<0.01, ***P*<0.001.

FEV₁, forced expiratory volume in 1 s; FEV₆, forced expiratory volume in 6 s, PEFR, peak expiratory flow rate.

Table 2: Correlation of BMI, FMI, and FFMI with dynamic lung functions in male and female subjects

Parameters	Male subjects (n = 102)			Female subjects (n = 84)		
	BMI	FMI	FFMI	BMI	FMI	FFMI
FEV ₁	0.482**	0.132	0.550**	-0.142	-0.367**	0.102
FEV ₆	0.492**	0.149	0.568**	-0.115	-0.329**	0.104
PEFR	0.630**	0.203*	0.702**	0.180	-0.044	0.366**

Values indicate Pearson's correlation coefficient, *r*

P*< 0.05 and *P*<0.01

lung functions, a nonsignificant negative association is found between BMI and FEV₁ and FEV₆ in our study.

A significant positive association of FFMI with FEV₁ and FEV₆ is seen only in male subjects but not in female subjects, which suggests muscle mass is directly associated with high lung functions in young Gujarati Indian male subjects.^[2,14] Increased FFM suggests the overall increase in body muscle mass and indirectly the strength of respiratory and abdominal muscles. A significant negative correlation of FMI with FEV₁ and FEV₆ is seen in female subjects, which suggests reduced lung functions with fatness.^[10,12,13] Central adiposity and fatness are associated with difficulty in descent of diaphragm and elastic recoil. At the same time, a significant positive association of FEV₁ and FEV₆ is seen with BMI in male subjects but negative association of FEV₁ and FEV₆ is found in female subjects. Our study suggests that lung functions prediction with FMI and FFMI is more reliable than only with BMI. BMI gives a rough idea of body weight but FM and FFM are more acceptable measures for understanding various body functions.

Conclusion

In female subjects, FM is associated with reduced lung functions. BMI and FFMI show a positive association with lung functions in male subjects. The association of body composition with lung functions in male and female subjects with larger sample is required to understand their better correlation.

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