Short Communication

Effect of body mass index on gender difference in lung functions in Indian population

Anugya Aparajita Behera, Basanta Kumar Behera[1], Somnath Dash[2], Soumya Mishra[3]

Department of Physiology, IMS and SUM Medical College, [1]Department of Community Medicine, Kalinga Institute of Medical Sciences, KIIT University, Bhubaneswar, Odisha, [2]Department of Pulmonary Medicine, GSL Medical College, Rajahmundry, Andhra Pradesh, [3]Department of Physiology, JIPMER, Puducherry, India

Abstract

Lung function tests have been known to be associated with a variety of factors such as age, sex, race, ethnicity, height, weight, chest circumference, waist circumference, waist-hip ratio, body mass index (BMI), etc. Increasing trend of obesity in developing country such as India leads to change in pulmonary function tests. The present study was undertaken to assess how BMI contributes to change in vital capacity (VC), forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), ratio between FEV1 and FVC (FEV1/FVC) and peak expiratory flow rate (PEFR) and if there was any difference between patterns in males and females. The 60 healthy subjects were included in the present study within the age group of 20–65 years. The BMI of each subject was calculated, and correlation was done between BMI and the lung function parameters. In males, PEFR was correlated with BMI, while in females it was significantly correlated with VC, FEV1, FVC, and PEFR. Applying multivariate analysis, we obtained odds ratio that supported females had a stronger correlation when compared to males. BMI contributes independently to pulmonary function tests, and the correlation pattern was different for males and females.

Key words: Body mass index, gender-difference, pulmonary function tests, vital capacity

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INTRODUCTION

Obesity is now categorized as a “disease” condition by the World Health Organization (WHO). WHO has recommended recommends the use of body mass index (BMI) as the simplest form of defining obesity.[1-3] As per the Asian classification, BMI of 18-23.4 kg/m^2 is considered normal, BMI below 18 kg/m^2 is considered as underweight, BMI of 23.5–27.4 kg/m^2 is considered overweight and BMI of 27.5 kg/m^2 or higher is considered obese.[4]

BMI has also shown its importance in the prediction of various disease conditions, the most important being the predictor of cardiovascular risks.[3] However, the link between BMI and lung function test is yet to be explored in detail.[5]

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Previous studies have well established the association of age, sex, and anthropometric indices with pulmonary functions.[6-10] Keeping in view the current trends in the field of pulmonary function testing (PFT), the present study was taken up to analyze how the BMI influences the various PFTs in both males and females.

MATERIALS AND METHODS

Sixty subjects in the age group of 20-65 years were included in this study. Institutional ethics committee approved the study protocol, and the written informed consent was taken from all the subjects. All the subjects were nonsmokers and had no prior history of cardio-pulmonary diseases. Asthma, severe anemia, chest or abdominal pain of any cause, or history of any disease which can be expected to affect pulmonary function such as neuromuscular disorder, cardio-pulmonary disorder, etc., were excluded from the study. The females selected

Address for correspondence: Dr. Soumya Mishra, Department of Physiology, JIPMER, Dhanvantri Nagar, Puducherry - 605 006, India. E-mail: drsoumya_mishra@yahoo.co.in

for the study were non-pregnant and non-lactating. The subjects who had prior habit of tobacco chewing and smoking were also excluded from the study.

Detailed medical history, physical examination and PFT were undertaken for each subject. Micro Medical Super Spiro (manufactured by Micro Medical Ltd., Rochester, Kent, England) was used to assess the pulmonary function parameters such as vital capacity (VC), forced expiratory volume in 1 s (FEV1); forced vital capacity (FVC), ratio between FEV1 and FVC (FEV1/FVC) and peak expiratory flow rate (PEFR).

Statistical analysis was performed using SPSS software version 16.0 (Chicago, Inc., IL, USA) and all the data were presented as mean ± standard deviation. The level of significance between the groups was tested by Student's unpaired *t*-test and the Pearson's correlation coefficient and multiple regression analysis was used to assess the independent contribution of BMI to various factors. $P < 0.05$ was considered as statistically significant.

RESULTS

The baseline physical characteristics and PFT parameters showed a normal distribution. A comparison of the physical characteristics and lung function test parameters between the male ($n = 30$) and female ($n = 30$) subjects are depicted in Table 1. On applying unpaired Student's *t*-test between the males and females, we found statistically significant gender-difference, except for age and BMI which was not found to be significant.

Correlation was assessed between BMI and the PFT parameters to assess which parameters are affected by change in BMI. Table 2 depicts the Pearson's correlation coefficient (*r*) between BMI and PFTs. Adjusting for age, we used multivariate regression to assess if BMI independently contributes to the PFTs. It was observed that in males BMI contributes only to PEFR while, in females, it contributes independently to VC, FEV1, FVC and PEFR [Table 3].

Table 1: Physical characteristics and pulmonary function tests in male and female subjects

	Male (*n*=30)	Female (*n*=30)	*P*
Age (in years)	42.37±15.39	40.77±13.33	0.668^{ns}
Height (in m)	1.66±0.07	1.55±0.07	0.0001
Weight (in kg)	69.53±11.98	61.73±12.61	0.017
BMI (kg/m^2)	25.22±4.38	25.75±5.79	0.69^{ns}
VC (in L)	3.45±0.82	2.13±0.66	0.0001
FEV1 (in L)	2.99±0.72	2.04±0.52	0.0001
FVC (in L)	3.36±0.83	2.17±0.53	0.0001
FEV1/FVC	89.73±6.89	93.57±4.24	0.012
PEFR (in L/min)	380.57±130.81	249.03±91.21	0.0001

SD: Standard deviation, BMI: Body mass index, VC: Vital capacity, FEV1: Forced expiratory volume in 1 s, FVC: Forced vital capacity, FEV1/FVC: Ratio between forced expiratory volume in 1 s and forced vital capacity, PEFR: Peak expiratory flow rate, NS: Not statistically significant (P<0.05 considered statistically significant). Data are expressed as mean±SD

Table 2: Correlation of BMI with pulmonary function tests in males and females

Parameters	Males (*n*=30)		Females (*n*=30)	
	r	*P*	*r*	*P*
VC (L)	−0.14	0.48^{ns}	−0.41	0.02
FEV1 (L)	−0.31	0.10^{ns}	−0.47	0.01
FVC (L)	−0.33	0.07^{ns}	−0.44	0.01
FEV1/FVC	0.07	0.70^{ns}	0.14	0.46^{ns}
PEFR (L/min)	−0.37	0.04	−0.46	0.01

BMI: Body mass index, VC: Vital capacity, FEV1: Forced expiratory volume in 1 s, FVC: Forced vital capacity, FEV1/FVC: Ratio between forced expiratory volume in 1 s and forced vital capacity, PEFR: Peak expiratory flow rate, *r*: Pearson's correlation coefficient, NS: Not statistically significant (*P*<0.05 considered statistically significant)

Table 3: Multivariate regression of pulmonary function tests with BMI in males and females

Parameters	Males (*n*=30)		Females (*n*=30)	
	OR (95%CI)	*P*	OR (95%CI)	*P*
VC (L)	−0.025	0.47^{ns}	−0.047	0.02
FEV1 (L)	−0.05	0.10^{ns}	−0.041	0.01
FVC (L)	−0.063	0.06^{ns}	−0.04	0.01
FEV1/FVC	−0.115	0.70^{ns}	−0.104	0.45^{ns}
PEFR (L/min)	−10.938	0.04	−7.213	0.01

NS: Not statistically significant (*P*<0.05 considered significant). OR: Odds ratio, CI: Confidence interval, VC: Vital capacity, FEV1: Forced expiratory volume in 1 s, FVC: Forced vital capacity, FEV1/FVC: Ratio between forced expiratory volume in 1 s and forced vital capacity; PEFR: Peak expiratory flow rate, BMI: Body mass index

DISCUSSION

This study reports the findings of the association between BMI and lung functions based on gender-differences in healthy nonsmoking adults in the age group of 20-65 years. It was found that males had higher mean values of the PFT parameters when compared to females. Previous studies also report similar results.[11,12] This can be attributed to the fact that men have bigger lungs for the same height as compared to females. Another contributing factor could be the muscularity in men that accounts for higher values of PFTs. Sex hormones, sex hormone receptors or intracellular signaling pathways in addition to the anatomical and physiological differences may also be responsible for the gender-difference in lung functions.[13,14]

Our study also showed a negative correlation between BMI and lung functions similar to other studies.[15-17] With the increase in BMI, the FEV1 was decreased indicating the increase in the restrictive pattern of lung function. However, some studies showed that FEV1 had no relationship with BMI[18] while other studies showed a positive correlation to all lung function tests.[2,19] But in our study, the FEV1/FVC ratio showed positive low correlation and was not significantly associated with BMI in both males and females. One study also showed a similar pattern,[15] suggesting the restrictive pulmonary effects of increased BMI. As compared to previous studies we found stronger and statistically significant association of the PFTs with BMI.[15,20] But, the difference in correlation pattern in males and females is scantily documented, which adds to the strength of our study. Our results indicate a significant association of VC with BMI in case of females, though a recent study shows no statistical significance.[20] Such difference in results of correlation between BMI and PFTs might be due to the inclusion of only younger age subjects, while we had a wide range of age group.

The major limitation of our study is smaller sample size. Also the duration and cause of increased BMI was not known. Another limitation is that, we could not record all the lung function test parameters and lung volumes. Future longitudinal studies incorporating a larger sample size can be taken up to study the effect of BMI on lung volumes and lung function tests to provide a deeper insight.

CONCLUSION

We state that BMI, which is a reliable measure of obesity, had significant effects on pulmonary function, which differed in males and females. Association of BMI with PFTs and the pattern of difference among males and females appear to be complex.

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