Short Communication

Gender difference on the effects of body mass index in prediction of spirometric reference values in healthy young Indian adults

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Abstract

Pulmonary function tests (PFTs) in different populations have been reported from different parts of the globe. Owing to increased industrialization and changes in the anthropometric profile, it is essential to readdress the population-specific spirometric norms. Body mass index (BMI) is known to influence lung functions. Therefore, the present study was aimed to assess the gender difference on the effects of BMI in prediction of spirometric reference values in healthy young Indian adults. A total of 158 university students (90 males and 68 females) were randomly sampled from the University of Calcutta, India. PFTs were measured in all subjects using expirograph. There was no significant difference in age between males and females. Significant gender variation was found in vital capacity (VC), forced vital capacity, forced expiratory volume in 1s, forced expiratory flow and peak expiratory flow rate. BMI depicted significant correlation with VC in males. On the basis of existence of such significant correlations, regression equations were computed to predict PFTs from BMI. To conclude, the study indicated a significant gender variation in the normal values of the PFTs. BMI was negatively correlated with VC in males, and the level of BMI showed better prediction of pulmonary function in male subjects.

Key words: Forced expiratory volume in 1s, forced vital capacity, Indian, prediction, pulmonary function

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INTRODUCTION

Physical fitness is required not only for sportsperson but also for sedentary people to maintain the physical and mental health. Pulmonary function tests (PFTs) are the important long-standing predictors of physical fitness in both genders and are essential to evaluate the individual's respiratory system for diagnosis, treatment, and rehabilitation of respiratory abnormalities.[1] Severity of airway obstruction and functional derangement of pulmonary system are also reflected in spirometric tests. Normal pulmonary function measurements and the effects of ethnicity, anthropometric parameters, and habitat on these parameters have been reported in Indian,[1,2] Chinese,[3] Malaysian,[4] Europeans,[5] and other non-Caucasian[6] populations.

Obesity and physical activity are the major factors that affect pulmonary functions.[7] Though it is known that obesity causes decrease in lung volumes, there is no systematic study demonstrating the prediction of pulmonary function by body mass index (BMI). Though there are reports on the pulmonary function of healthy individuals (20-59 years) of Kolkata two decades before,[8] the applicability of regression norms proposed in these studies are needed to be revisited with special reference to the impact of gender variation and BMI. Therefore, the present study was designed to evaluate the pulmonary functions in young healthy university students of Kolkata and to assess the effect of gender on BMI prediction of PFTs.

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MATERIALS AND METHODS

After obtaining the ethical clearance from the Human Ethics Committee, University of Calcutta, a total of

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158 university students (male = 90, female = 68, age range: 19-24 years) with similar socioeconomic background were randomly sampled from the postgraduate section of University of Calcutta, India. Students who exercised regularly, those with a history of respiratory diseases, and those on medication for respiratory diseases were excluded from this study. The experimental protocol was explained and demonstrated to all the subjects to allay their apprehensions. A written informed consent was obtained from each subject. The body height was measured with the subject standing barefoot with an accuracy of + 0.50 cm, and the body weight was measured to an accuracy of + 0.1 kg by using a weight measuring instrument fitted with a height measuring rod (Avery India Ltd., India) with the subject wearing minimum clothing. BMI was calculated as the ratio between body weight (kg) and squared body height (m^2).[9]

The pulmonary functions were recorded on all subjects using a 9-L closed-circuit-type expirograph (Toshniwal Technologies Pvt. Ltd., India). The parameters measured included tidal volume (TV), vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1), FEV_1 as a percentage of FVC ($FEV_{1\%}$), mid-expiratory flow rate, and forced expiratory flow ($FEF_{25-75\%}$). The peak expiratory flow rate (PEFR) was recorded using a Wright peak flow meter. The expirograph was calibrated daily using a Palmer respiratory hand pump. All the measurements were conducted according to Chatterjee and Saha.[8] The subjects were encouraged and motivated to attain the maximum possible effort. Pulmonary function testing was done at noon before lunch in the sitting posture. All pulmonary function measurements were performed at body temperature and pressure saturated with water vapor (BTPS).

Statistical analysis

Sample size was calculated by Dupont and Plummer's method.[10] Data were expressed as mean ± standard deviation (SD). Student's unpaired *t*-test was adopted to compare the pulmonary function measurements and physical parameters between the genders. Pearson's product-moment correlation coefficient (*r*) was computed to test the significant relationship between two parameters. Regression analysis was done to compute the prediction norms for predicting pulmonary function measurements with BMI. $P < 0.05$ was considered significant.

RESULTS

Table 1 shows the values of physical parameters and pulmonary function measurements. The mean age of male and female subjects in the present study was 22.18 ± 1.97 and 22.06 ± 2.81 years, respectively. There was no significant difference in age between males and females. Significant gender difference was found in body weight, BMI, VC, FVC, FEV_1, $FEF_{25-75\%}$, and PEFR ($P < 0.001$) [Table 1]. Table 2 shows the correlation of BMI with pulmonary function parameters in males and females. Among all pulmonary function parameters, BMI correlated significantly with VC only in males and not in females [Table 2]. Results of multiple-regression equation for the prediction of pulmonary function measurements from BMI in both the genders have been tabulated in Table 3. The independent prediction of BMI on VC is found to be significantly high in males despite the high BMI in females [Table 3].

DISCUSSION

In the present study, lung function parameters namely VC, FVC, FEV_1, $FEF_{25-75\%}$, and PEFR were found to be significantly high in males when compared to females ($P < 0.001$) [Table 1]. Previous studies have also reported a significant gender difference in lung function parameters.[11,12] However, in the present study pulmonary function parameters were found to be within the normal range in the study population. Increased BMI is a good index of obesity. VC primarily reflects the ability of the lungs and chest to expand. In the present study, though BMI was significantly more in females [Table 1], it exhibited a significant negative correlation with VC in males [Table 2]. This indicates that BMI might have inverse relationship with VC in males, but not in females. A previous study has reported significant decrease in pulmonary function parameters among obese children and adolescents, and diminution in FVC, FEV_1, PEFR, and $FEF_{25-75\%}$ is related to the degree of obesity.[13] The present observation is in agreement with earlier reports that suggested the effect of weight gain on pulmonary function was higher in men than

Table 1: Values of physical parameters and pulmonary function measurements in male and female university students

Parameters	Male (*n*=90)	Female (*n*=68)	*P* value
Age (years)	22.18±1.97	22.06±2.81	0.616
Body weight (kg)	60.70±9.17	50.30±8.35	<0.001
BMI (kg/m²)	22.03±3.1	24.16±3.98	<0.001
VC (l)	3.97±0.53	2.20±0.35	<0.001
FVC (l)	3.74±0.51	2.05±0.31	<0.001
FEV_1 (l)	3.36±0.63	1.81±0.25	<0.001
$FEV_{1\%}$ (%)	89.51±7.98	89.34±10.11	0.912
FEF_{25-75} (l min⁻¹)	276.05±72.32	200.85±48.26	<0.001
PEFR (l min⁻¹)	668.30±69.76	461±31	<0.001

Values expressed are mean±SD, SD: Standard deviation M: Male, F: Female. BMI: Body mass index, VC: Vital capacity, FVC: Forced vital capacity, FEV_1: Forced expiratory volume in 1 s, $FEV_{1\%}$: FEV1 as a percentage of FVC, $FEF_{25-75\%}$: Mid expiratory flow rate, $FEF_{75-85\%}$: End expiratory flow rate, PEFR: Peak expiratory flow rate. Statistical analysis was done by unpaired Student's *t* test. The $P<0.05$ was considered statistically significant

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

Parameters	BMI	
	Male	Female
VC (l)	−0.34*	0.10
FVC (l)	−0.15	0.09
FEV_1 (l)	−0.07	−0.083
FEV_1% (%)	−0.09	−0.20
$FEF_{25\text{-}75\%}$ (l min^{-1})	−0.18	−0.013
PEFR (l min^{-1})	−0.22	0.17

P<0.05 was considered statistically significant. BMI = Body mass index, VC: Vital capacity, FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 s, $FEV_{1\%}$: FEV1 as a percentage of FVC, $FEF_{25\text{-}75\%}$: Mid expiratory flow rate, PEFR: Peak expiratory flow rate

Table 3: Simple regression norms for the prediction of pulmonary function measurements from BMI in males

Parameter	Male (*n*=90)			
	RE	*r*	r^2	SEE
VC (l)	0.06±2.69	−0.34*	0.1156	0.50

P<0.05 was considered statistically significant. SEE: Standard error of estimate, BMI: Body mass index, RE = Regression equation, NS: Not significant, VC: Vital capacity. Statistical analysis was done by multiple regression analysis

in women.[14,9] In the present study, though the BMI in males was within normal range, the females were in overweight range as per Asian classification of BMI. However, BMI had no significant correlation with VC in females. Though BMI was negatively correlated with VC in males, and BMI had significant prediction of VC in males but not in females. However, from the findings of the present study it cannot be definitively said that the association between BMI and VC does not exist in females as the sample size was relatively small for females. As there was no significant correlation of BMI with VC in females [Table 2], the regression equation for BMI-prediction of VC was not done in females. Further, the subjects in the present study were university students at younger group. Usually, BMI fluctuates more at younger age and therefore BMI does not strongly correlate with pulmonary function in younger population. Therefore, studies in a larger sample size in obese adult population should be conducted to further substantiate the gender difference in influence of BMI on pulmonary functions.

CONCLUSION

Though BMI was less in males compared to females, the BMI had significant correlation with VC in males, but not in females. Also, BMI had significant prediction of VC in males. Nevertheless, the study should be done in a larger sample size in both the genders to assess the gender difference in predictive power of BMI on pulmonary functions.

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