Original Article

Adiposity: Determinant of Peak Expiratory Flow Rate in Young Indian Adults Male

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ABSTRACT

Background. Although several factors such as respiratory muscle strength, lung compliance, resistance to airflow, and even obesity affect the lung functions, the nature of relationship with markers of adiposity is not clear. We hypothesised that central pattern of fat distribution is a significant predictor of decreased peak expiratory flow rate (PEFR). The present study was designed with the aim to examine the effects of adiposity on PEFR in males.

Methods. One hundred young healthy male volunteers were analysed in the study. They were classified into non-obese, and obese groups based on body mass index (BMI) (obese ≥30Kg/m^2 and non-obese <30Kg/m^2). The PEFR was measured by using Wright's peak flow meter. Data was analysed using unpaired 't' test for statistical significance of differences between the non-obese and the obese, stratified into age groups of 20 to 30 years and 30 to 40 years. A partial correlation adjusted to age, height and BMI followed by regression analysis was conducted using adiposity markers as a predictor of PEFR.

Results. The model adjusted to age, height, weight and BMI revealed waist hip ratio (WHR) as the only parameter which shows significant variance in PEFR with a Pearson's r=-0.59, F (1, 100)=12.23, p=0.04. The resulting linear regression equation is y=-388.72xWHR+850.68.

Conclusions. Our findings suggest that obesity itself and especially the pattern of body fat distribution have independent effects on PEFR. These results suggest that abdominal adiposity, measured as WHR, is a better predictor of expiratory flow than weight or BMI. **[Indian J Chest Dis Allied Sci 2011;53:29-33]**

Key words: Pulmonary function, PEFR, Obesity, Adiposity marker.

INTRODUCTION

Pulmonary functions are generally determined by respiratory muscle strength, compliance of the thoracic cavity, airway resistance and elastic recoil of the lungs.[1] It is well known that pulmonary functions may vary according to the physical characteristics including age, height, body weight[2], and altitude (hypoxia or low ambient pressure).[3] Significant regional differences in lung functions in healthy Indians have been reported.[4,5]

For demonstrating the narrowing of airways, different expiratory flow rates are employed. Peak expiratory flow rate (PEFR) is one such parameter that can be easily measured by a peak flow meter and is a convenient tool to measure lung functions in a field study.[6] It is a fairly good indicator of bronchial hyperresponsiveness,[7] and does not require body temperature pressure saturated (BTPS) correction. The PEFR values are affected by various factors, such as sex, body surface area, obesity, physical activity, posture, environment and racial differences.[8-10] Obesity has been linked with impaired pulmonary function and airway hyperresponsiveness,[11,12] but not in all studies[13] and with asthma in adults.[14-16]

Excess body weight as in an obese or overweight person is normally due to accumulation of extra body fat.[17] However, it could also be due to other causes and can show variations in regional distribution.[18] Weight and body mass index (BMI) as measures of overall adiposity are used as predictors of pulmonary function in many epidemiological studies.[19-21] While these measures are widely accepted as determinants of pulmonary function, waist hip ratio (WHR)[22] and waist circumference (WC),[23,24] often used as a surrogate measure for abdominal or upper body obesity may influence pulmonary function

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mechanically[25] by changes in compliance, work of breathing and the elastic recoil.[26,27] Therefore, markers of obesity, such as BMI,[28] WC[29] and WHR[30] may be correlated to PEFR.

Most of the studies regarding the effect of obesity on pulmonary function tests have been conducted in males, in the age group of 5 to 16 years or in the elderly age groups.[31,32] Further, these studies have not considered the pattern of fat distribution that may affect the pulmonary function.

The PEFR in the obese individuals should be lower, as the extra fat would exert a mechanical effect on the movement of chest or abdomen but the predictability of different adiposity markers for deranged PEFR may vary across populations. Therefore, the present study was undertaken to establish the relationship between lung functions and adiposity measures in young male adults of Garhwal.

MATERIAL AND METHODS

The study was conducted on healthy young male volunteers from university population and nearby area of Bhaniyawala, Dehradun, Uttarakhand. One hundred volunteers were selected between the age group of 20 to 40 years. The nature of the study was explained and informed consent was obtained from each subject prior to participation in the study. The protocol of the study was approved by the Institutional Ethics Committee.

To rule out any obvious cardio-pulmonary compromise, a detailed history was taken and clinical examination of the subjects was done. Subjects with history of smoking, severe chest trauma, obvious chest and spinal deformity, personal/family history of asthma, chronic obstructive pulmonary diseases and other cardio-respiratory diseases were excluded from the study. The volunteers were asked to avoid beverages, like tea and coffee and other stimulants with light breakfast before reporting to the Department of Physiology, HIMS, in the forenoon to avoid diurnal variation in respiratory parameters. Volunteers were subjected to anthropometry at the point of entry using the standard procedures and instruments as per the study protocol.

Age was recorded from date of birth to the nearest completed/approaching year (<6 months and >6 months). Standing height was recorded without shoes and with light clothes on a wall mounted measuring tape to the nearest centimetre (<5 mm and >5 mm). Weight was recorded without shoes and with light clothes on a Krups weighing machine with a least count of 100 grams. Body mass index was calculated by the formula of weight (in Kg) and height (in meters).[2]

$$BMI = Weight (Kg)/Height (meter)^2$$

Waist circumference (WC) measurement was done with minimal, adequate clothing (light clothes) with feet 25 to 30 cm apart and weight equally balanced with a tailor's measuring tape in a plane perpendicular to the long body axis at the level of umbilicus without compression of the skin to the nearest 0.1cm (WC≥90cm in males and ≥80cm in females were defined as abdominal obesity using World Health Organization Asia Pacific prospective guidelines).[33] Hip circumference (HC) measurement was done with minimal, adequate clothing (light clothes) across the greater trochanter with legs and feet together by a measuring tape without compressing the skin fold. The ratio of WC, WHR and HC, was calculated. It is a measure of central pattern of fat distribution (>0.9 for males and >0.8 for females).[33]

The PEFR was recorded with Wright's portable peak flow meter according to the standard procedure. At least three readings were obtained under supervision and the best of the three was recorded.[11,12] A close watch was kept to ensure that a tight seal was maintained between lips and the mouthpiece of the peak flow meter. The procedure was performed in a spacious room with regulated temperature during the morning hours between 9 AM to 11 AM in the months of March and April. The pooled data were subjected to statistical analysis.

Statistical Analysis

Patients were stratified according to the age groups of 20 to 30 years and 30 to 40 years into obese and non-obese volunteers according to the WHO criteria with BMI ≥30 Kg/m^2 as obese and BMI <30 as non-obese. Analysis was carried out to identify which of the adiposity markers showed difference in the PEFR among the groups within 95% of confidence limit. Partial correlation among the PEFR and adiposity markers was determined to see the association of the parameter with adiposity. Most significant predictable markers were analysed by step-wise regression analysis to make the model acceptable for the epidemiological studies.

RESULTS

No significant differences in age or height were found among the two groups studied. However, as expected, weight, BMI, WC and WHR were significantly higher in obese as compared to non-obese groups (Table 1). Mean values of PEFR showed significantly lower values (393.6±51.1) only in obese males of the higher age group. The absolute values of PEFR were higher in the lower age group as compared to the higher age group.

Table 1. Mean anthropometric data, body mass index (BMI), waist circumference (WC), and waist hip ratio (WHR) in obese and in non-obese males

	20-30 years		30-40 years	
	Non-Obese (n=25)	Obese (n=25)	Non-Obese (n=25)	Obese (n=25)
Age (years)	25.4±3.0	24±3.5	36±3.1	34.8±3.0
Height (m)	1.6±0.1	1.7±0.1	1.69±0.8	1.7±0.1
Weight (Kg)	64.2±5.7	96.5±4.6*	71.9±11.3	96.2±8.4*
BMI (Kg/m^2)	24.7±1.1	34.5±2.1*	24.9±2.4	32.1±3.8*
WC (cm)	88.8±2.8	107.5±7.5*	105.1±15.5	124.4±7.5*
WHR	0.8±0.1	0.9±0.1*	0.9 0.1	1.1±0.1*
PEFR (L/min)	489±56.2	518.2±24.5	507.6±41.6	393.6±51.1*

Variables are expressed as mean±SD; *=p<0.05
PEFR=Peak expiratory flow rate

Partial correlation analysis of the adiposity markers after adjusting for age and height showed an inverse correlation of PEFR with all the adiposity markers but significant association was seen only with WHR (Table 2). Linear regression analysis was conducted including independent parameters like age, height, BMI, WC and WHR as predictors of PEFR.

Table 2. Partial correlation coefficient of adiposity markers with PEFR adjusted for age and height in males (n=100)

	Weight (Kg)	BMI (Kg/m^2)	WC (cm)	WHR	PEFR (L/min)
Weight (Kg)	1.00	0.997*	0.845*	0.462**	-0.2078
BMI (Kg/m^2)	-	1.00	0.8257*	0.4363**	-0.1811
WC (cm)	-	-	1.00	0.4916***	-0.3118***
WHR	-	-	-	1.00	-0.5951+
PEFR (L/min)	-	-	-	-	1.00

*=p<0.0001, **=p<0.01, ***=p<0.05, +=p<0.001
PEFR=Peak expiratory flow rate; BMI=Body mass index; WC=Waist circumference; WHR=Waist hip ratio

The model revealed that WHR was the only significant predictor of the variance in PEFR with a Pearson's r=-0.59, F (1, 100)=12.23, p=0.04 (Table 3). Scatter plot between PEFR and WHR among the males show a negative correlation. The resulting linear regression equation is y=-388.72xWHR+ 850.68 (Figure).

Table 3. Regression coefficients Beta for adiposity markers entered into model with PEFR (n=100)

Variable	Beta (p value)
Age (years)	-0.056 (0.08)
Height (m)	0.313 (0.12)
WC (cm)	-0.15 (0.7)
BMI (kg/m^2)	0.11 (0.68)
WHR	-0.56 (0.04)

PEFR=Peak expiratory flow rate; WC=Waist circumference; BMI=Body mass index; WHR=Waist hip ratio

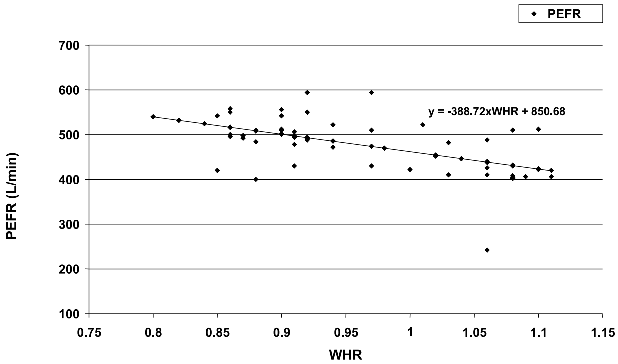

Figure. Scatter plot showing relationship of PEFR and WHR.

DISCUSSION

The primary factors that affect PEFR are the strength of the expiratory muscles generating the force of contraction, the elastic recoil pressure of the lungs and the airway size.[32]

Abdominal adiposity may influence pulmonary functions by restricting the descent of the diaphragm and limiting lung expansion as compared to overall adiposity which may compress the chest wall. We found that PEFR is negatively associated with adiposity markers, as measured by BMI, WC and WHR, after the effects of variation in age and height were removed.

On multivariate analysis, WHR was found to be the only most significant parameter that showed significant negative association with PEFR while age, height, BMI and WC were not. Similar findings were observed by Collins *et al*[30] who reported a lower FEV_1 in subjects with higher WHR even without adjustment for age, stature and relative obesity. However, regression analysis reported no significant effect of WHR on flow rates.[30] Chen *et al*[28] in a six-year follow-up study on patients with the extreme obesity (W/H >0.9) have reported that forced expiratory flow during mid expiratory phase was significantly reduced. In another study, Chen *et al*[23] showed a positive correlation between maximum mean expiratory flow (MMEF) and increasing BMI, that was significant in the middle age group of 40 to 69 years. The MMEF is generally regarded as "effort independent" and it may be that higher levels of BMI are associated with increased chest wall elastic recoil, and thus, with a change in the balance of elastic recoil.[27] Shaheen *et al*[14] found that obese men, but not women, had reduced maximum expiratory flow rates at 50% and 75% of exhaled vital capacity. In contrast to our study, Lazarus *et al*[21] observed no effect of the central pattern of fat distribution (WHR) in the mean age 35.2±1.3 years. Rather, upper body subcutaneous fat was significantly associated with the flow rates.

In the present study, PEFR values for obese individuals were found to be lower than the non-obese individuals only in the higher age group. However, the results were not significant when BMI was taken as a parameter of obesity. Correlation study has shown a negative relationship between BMI and PEFR. The study by Chinn *et al*[7] on young adults found evidence of linearity in relation of slope to BMI. The "Slope" declined with increasing BMI in males, that is, bronchial hyperresponsiveness increased. The statistical significance of the results was similar to our study. In the study conducted by Carey *et al*[22] on obese healthy subjects suggests that both total respiratory resistance and airway resistance increased significantly with the level of obesity, disclosing a significant linear relationship between airway conduction and functional residual capacity. However, the study by Ghabashi and Iqbal[34] on asthmatic patients suggested that, although obesity was prevalent in asthmatic patients, BMI did not correlate with any of the spirometric variables.

The lower values of PEFR could be linked to obesity through several mechanisms, such as mechanical effects on the diaphragm (impeding descent into the abdominal cavity) and also because of the fat deposition between the muscles and the ribs that can lead to increase in the metabolic demands and work-load of breathing.

Although the magnitude of the effect is relatively small from a public health perspective, our findings in the present study indicate the consequence of increased abdominal obesity on lung function. A larger sample size and a longitudinal study will definitely be of a great value in predicting the relationship between pulmonary function tests and abdominal obesity. Further, the association needs to be studied in female subjects.

CONCLUSIONS

The study concludes that adiposity, measured as WHR, affects the PEFR in young males in the age group of 20 to 40 years, especially in higher age group. After adjusting for BMI, a central pattern of fat distribution, as measured by WHR was associated with lower values for PEFR in young male adults. The findings of the present study suggest that the pattern of body fat distribution have independent effect on PEFR. These results suggest that WHR is a better predictor of pulmonary function than weight or BMI, and should be considered when investigating the determinants of pulmonary function.

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