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Association between peak expiratory flow rate and anthropometric obesity markers in young Bengali adults: A cross- sectional study

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Abstract

Objective*:* Modern lifestyle has resulted in an increased prevalence of cardiorespiratory diseases including hypertension and asthma along with being overweight or obese. The aims of this study were to evaluate the association between overall and abdominal obesity markers with peak expiratory flow rate (PEFR) among young adults.

Methods: The present cross-sectional study was conducted among college students aged 20-23 years from co-education colleges in West Bengal, India. Body mass index (BMI) which is considered as overall obesity indices was calculated from measured height and weight. Waist circumference (WC) a known central or abdominal obesity marker was measured. PEFR of all participants were estimated using Wright's peak flow meter. Pearson's correlation coefficient was used to determine the relationship between PEFR and obesity indices. P < 0.05 was considered statistically significant.

Results: PEFR of male participants was significantly ($p < 0.001$) higher in compare with female counterpart. Higher PEFR in male than female might be due to their greater height (167.06 $\pm$ 5.91 cm) in comparison with female (154.50 $\pm$ 5.72cm). PEFR was higher in normal weight group than either overweight or underweight group of participants irrespective to gender. Like body weight status central obesity affects PEFR. PEFR was significantly lower in centrally obese young males and females in respect to non-obese counterpart. Negative correlation was observed between PEFR with BMI and WC. PEFR increased with increasing BMI and WC up to a certain point and decrease thereafter.

Conclusion: Results of this study suggested significant association of PEFR with overall obesity as well as abdominal obesity markers. Maintaining a BMI in the range of 20.5-22.4 kg/m^2, waist circumference in the range of 71-75 cm for female and 76-80 cm for male participants is suggested for optimal pulmonary ventilation like PEFR.

Keywords: PEFR; Overweight; Gender; BMI; Waist circumference

1. Introduction

Pulmonary function tests are basic tool for assessing lung dysfunction, disease and prognosis of treatment. Forced expiratory volume after 1st second of exhalation (FEV1) is the gold standard test for pulmonary function. Spirometer, an expensive instrument is required for the measurement of FEV1. The PEFR is defined as maximal flow rate that is attained during a forceful expiratory effort after taking maximal inspiration. It can be measured relatively inexpensive Wright's peak flow meter. It is preferred among other pulmonary function test as it is simple and reliable diagnostic and prognostic test 1). This test may be performed in office, emergency department and as well as in home. It is a convenient method of measuring lung functions in in field surveys using portable instrument, Wright's peak flow meter.

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Obesity is a condition in which excess fat is accumulated in the body. Obesity is emerging as a global epidemic affecting both developed and developing countries. It is now considered as new world syndrome (2). In India the prevalence of obesity ranges from 10% to 50% (3). Among Indian more than 23% of women and 20% of men are either overweight or obese (4). Both over weight and obesity threat to both quality and duration of one's life. The modern life style is a potent risk factor for obesity and overweight. Declining physical activity levels and increased caloric intake are important contributor of obesity. BMI is now used as measure of overall adiposity. Waist circumference and waist – height ratio is used as measures of abdominal or central Obesity. Overall obesity is considered as predictor of pulmonary functional status however; central obesity mechanically influences pulmonary function (5). Obesity is associated with comorbidities like diabetes mellitus, hypertension, cardiac disease and respiratory impairment including asthma (6). Abdominal obesity is associated with worsening lung function (7). It is an important risk factor and disease modifier for asthma, obstructive sleep apnoea, obesity hypoventilation syndrome and pulmonary hypertension (8). Excess body fat reduces pulmonary compliance leading to mechanical impairment of respiratory muscle (9). Obesity is linked with a wide range of respiratory conditions like chronic obstructive pulmonary disease, obstructive sleep apnoea and asthma (9).

Kahlon et al (10) reported statistically significant correlation between BMI and PEFR while no such correlation in females. A study in 2016 reported weak correlation between PEFR and BMI (11). Prior studies have suggested conflicting links for the relationship obesity and PEFR (12). This study was undertaken to investigate whether there is any association between markers overall and abdominal obesity with PEFR among young adults.

2. Materials and methods

2.1. Study population

The present study was conducted among college students having age limit 20-23 years from three colleges in West Bengal, India during their college hours. The prior written permission of college authority was taken. Written consent from the participants in this study was obtained.

2.2. Inclusion criteria:

- Willing to participate in the study and signed the written informed consent
- Belonging to age limit 20-23 years

2.3. Exclusion criteria

- Smoking history
- Structural deformities of thoracic cage and spinal cord
- Subjects with personal history of asthma, COPD, clinically established hypertension and other cardiorespiratory diseases.
- Subjects who were athletes or involved in fitness training
- Subjects having metabolic disorder related to obesity.
- Not willing to participate

Sample size: Sample Size calculation for quantitative variable

$$\text{Sample size } (n) = (Z_{1\text{-alfa}/2})^2 \, (SD)^2 \; / \; d^2$$

$Z_{1\text{-alfa}/2} =$ Critical value and a standard corresponding level of confidence at 95% CI or 5%level of significance it is 1.96.

SD = Standard deviation

d = margin of error

In previous study reported a PEFR (l/min) of male 498 $\pm$ 10 and for female 352 $\pm$ 5 (13) which was used for sample size estimation.

d was considered as 2

n (for male) = 1.96 x 1.96 x 10 x 10 /2x2 = 96.04

n (for male) = 1.96 x 1.96 x 5 x 5 /2x2 = 24.01

Thus at least sample size would be 96 for male and 24 for female.

2.4. Anthropometric measurements

Body weight was measured using digital weighing scale accurate to 0.5kg with participants wearing light clothes and no shoes. For the measurement of height subjects were asked to stand still and quiet and erect position, hanging their arms freely and keeping their head aligned in the Frankfort plane. The measurements were recorded to the nearest 0.1 cm for each subject using anthropometric rod (14). BMI was calculated from the height and weight using following equation: BMI (kg/m^2) = weight (kg) / $height^2$ (m). BMI was calculated from the height and weight using following equation: BMI (kg/m^2) = weight (kg) / $height^2$ (m). WC was measured mid-way between iliac crest and lowermost margin of the ribs in quiet breathing using plastic tape (15).

2.5. PEFR measurement

PEFR was measured by using mini-Wright peak flaw meter (Cipla). All the participants were instructed first for the procedure of recording of PEFR. They were advised to maintain the erect posture and holding the peak flow meter in horizontal position. Each individual was asked to inhale deeply first and subsequently exhale maximally into the device with the aid of the mouthpiece. The participants were asked to perform this thrice and highest reading was noted for calculation. The instrument was wiped with cotton soaked in methylated spirit before every use.

2.6. Statistical analysis

Data were expressed as mean $\pm$ standard deviation. Student's t test for independent sample was adopted to compare study parameters between obese and non-obese. Pearson's product-moment correlation coefficient (r) was computed to evaluate relationship between two parameters. Statistical significance level was set at $p < 0.05$.

3. Results

The anthropometric data, blood pressure markers and PEFR of participants categorized based on gender are shown in table-1. Among obesity indices WC differ significantly but no difference of BMI between male and female participants. Height and PEFR differ significantly between males and females.

Table 1 Comparison of anthropometric data and PEFR on the basis of gender

Parameters	Male (n=143)	Female (n=229)	p
Height (cm)	167.06 + 5.91	154.50 + 5.72	< 0.001
Weight (kg)	60.81 + 13.23	52.68 + 11.44	< 0.001
BMI (kg/m2)	21.71 + 4.22	22.06 + 4.58	> 0.05
WC (cm)	79.98 + 10.71	75.82 + 10.10	< 0.001
PEFR (L/min)	452.73 + 79.82	264.43 + 54.52	< 0.001

Weight status of participants represents in fig-1. Among total participants 29% were underweight. 43.5% were normal weight, 23% were overweight and 4% were obese. Percentage of obese female participants were more (5%) than male participants (2.8%)

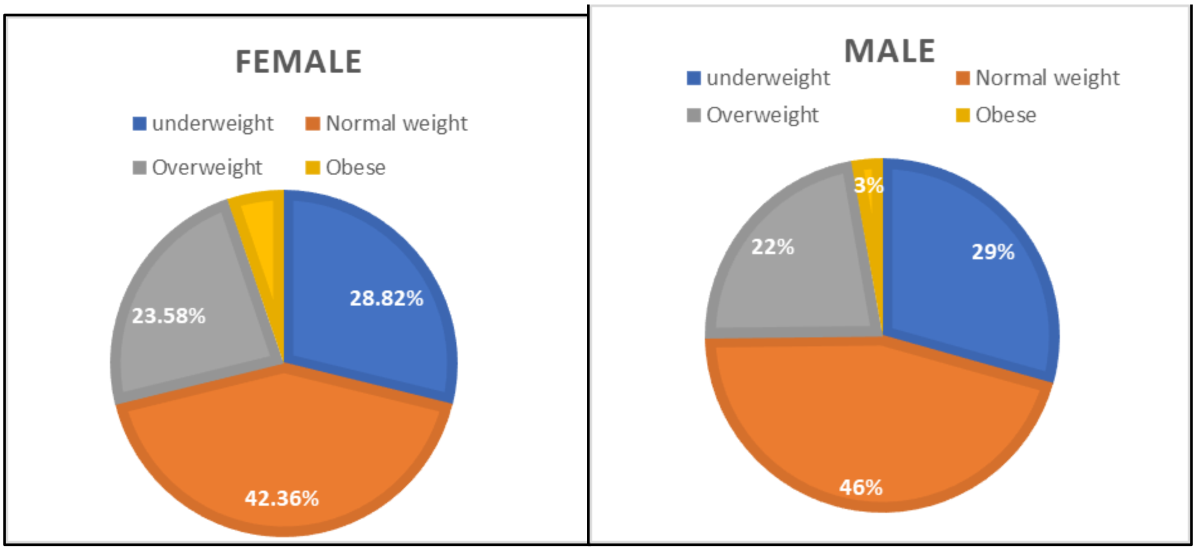


Figure 1 Distribution of study population on the basis of body weight status in respect to height

Table-2 presents PEFR on the basis of weight status. There is significant difference of PEFR between normal and overweight subjects as well as in between normal and underweight subjects. Irrespective to gender PEFR was significantly higher in normal weight participants than either underweight or obese participants.

Table 2 PEFR of study population in respect to BMI and Waist circumference

Parameters	Sub-parameter	Male		Female	
		PEFR (mean ± SD)	P*	PEFR (mean ± SD)	P*
BMI	Normal weight	482.77 ± 73.9	Ref.	286.36 ± 52.08	Ref.
	Underweight	425.24 ± 83.43	< 0.001	246.67 ± 39.18	< 0.001
	Overweight	431.67 ± 67.71	< 0.001	238.48 ± 56.63	< 0.001
WC	Normal	464.42 ± 83.39	Ref.	272.25 ± 40.06	Ref.
	Centrally obese	410.69 ± 37.50	< 0.001	248.11 ± 60.26	< 0.001

*p value was calculated in respect to normal weight participants of particular gender

On the basis of International Diabetes Foundation criteria for Asian population WC > 90 cm for male and > 80cm for females was considered as centrally obese. PEFR was significantly lower in centrally obese subjects irrespective to gender (table-2).

Table 3 Correlation between obesity markers and PEFR

Obesity indices	Sub-parameter	Male		Female	
		r	p	r	p
BMI	Normal weight	(-) 0.123	> 0.05^{NS}	0.155	< 0.01*
	Underweight	0.385	<0.001*	0.098	> 0.05^{NS}
	Overweight & obese	(-) 0.297	<0.001*	(-) 0.279	< 0.001*
	Overall	(-) 0.246	<0.001*	(-) 0.214	< 0.001
WC	Overall	(-) 0.186	<0.01*	(-) 0.191	< 0.01*

Table-3 represents correlation between obesity indices and PEFR. In overweight and obese group PEFR negatively correlated with BMI. PEFR was negatively correlated with WC. Scatter diagram (Fig-2 and Fig-3) showing gender wise the relation between WC and PEFR and in between BMI and PEFR among overall participants.

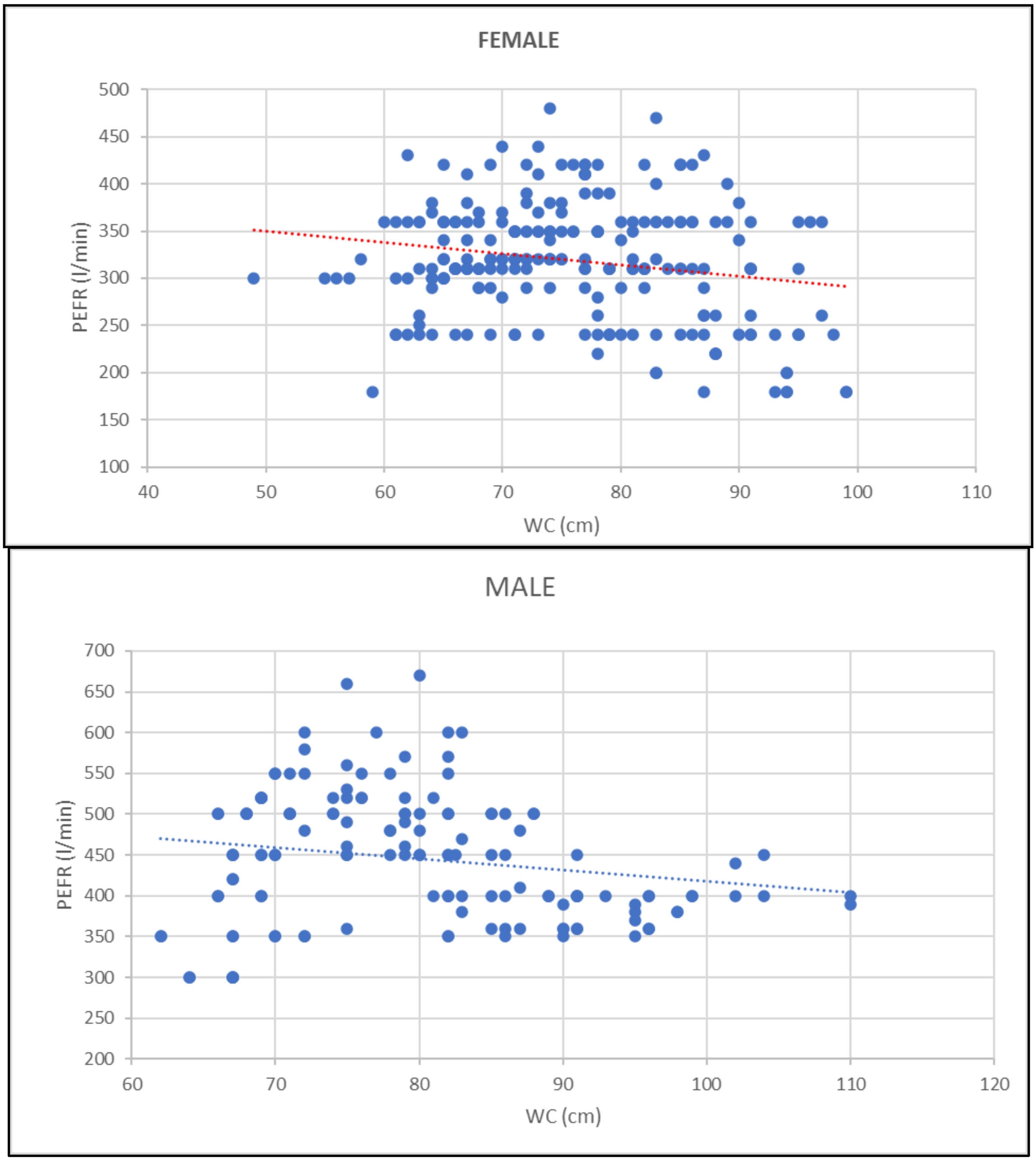
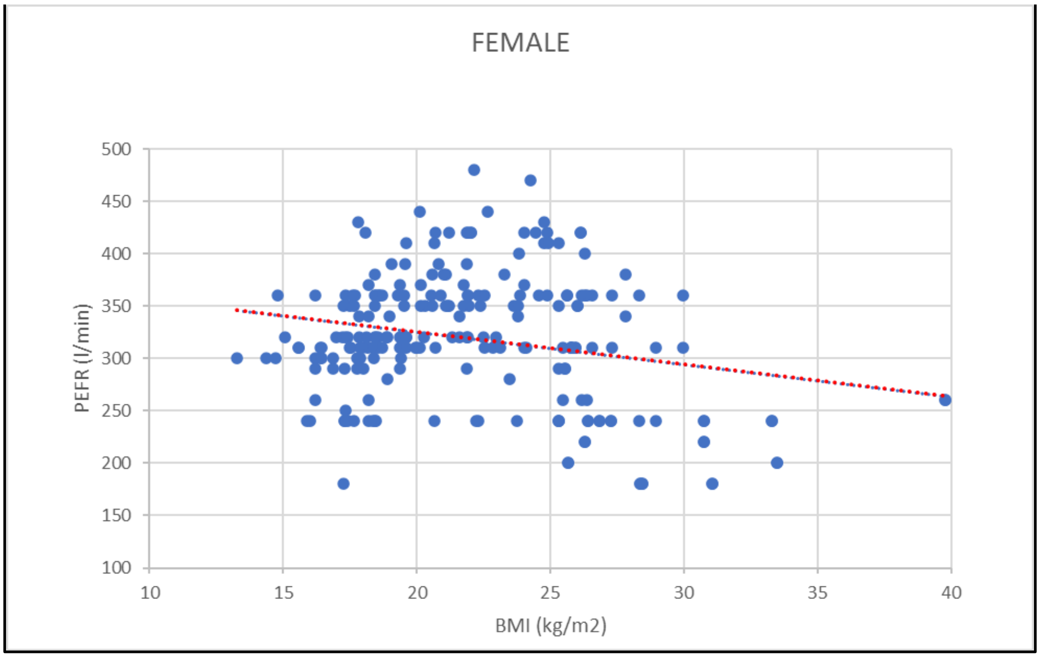


Figure 2 Scatter diagram showing relation between WC and PEFR among study population



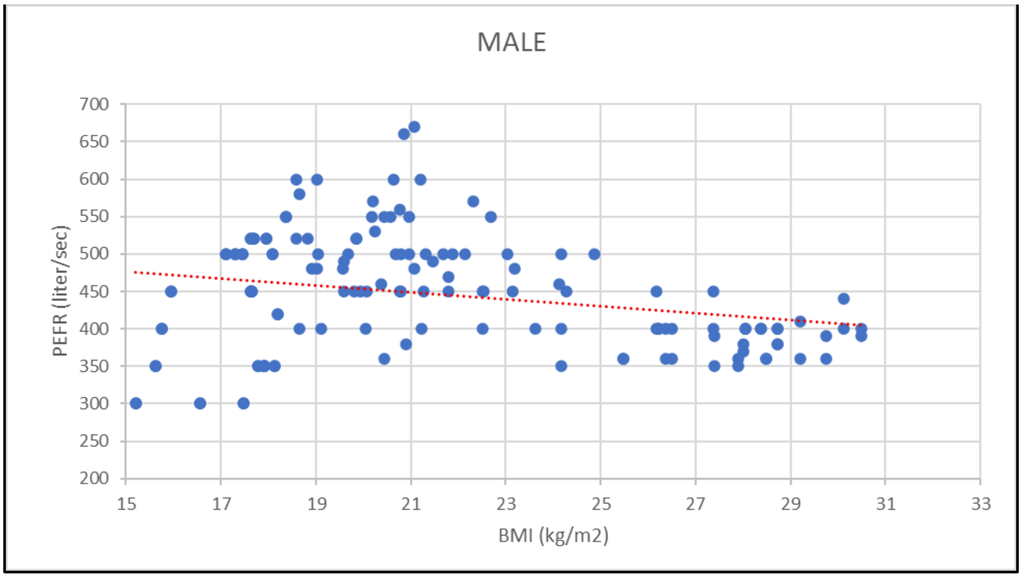
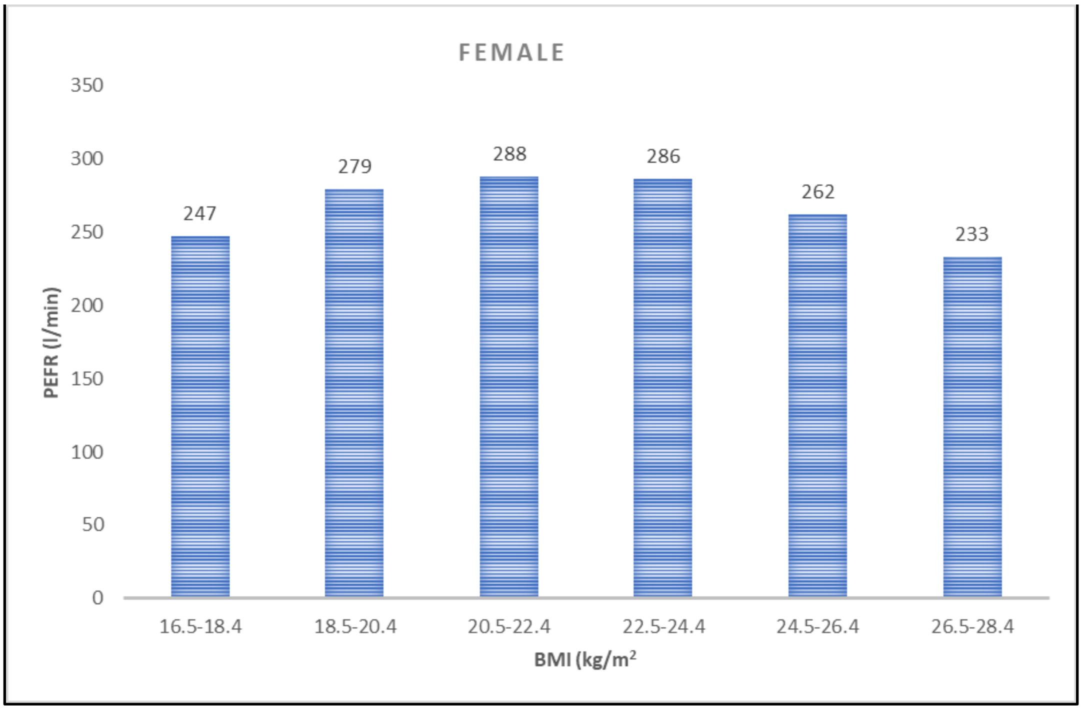


Figure 3 Scatter diagram showing relation between BMI and PEFR among study population

PEFR increases with increase of obesity markers up to a certain point and then begin to decrease with further increase of obesity. In case of overall obesity marker (BMI) maximum PEFR was noted in group having BMI 20.5-22.4 kg/m^2 for both male and female participants (Fig.4). Considering waist as obesity marker maximum PEFR was observed in group of females having waist circumference 71-75 cm and in male maximum PEFR was at waist circumference 76-80 cm (Fig-5).



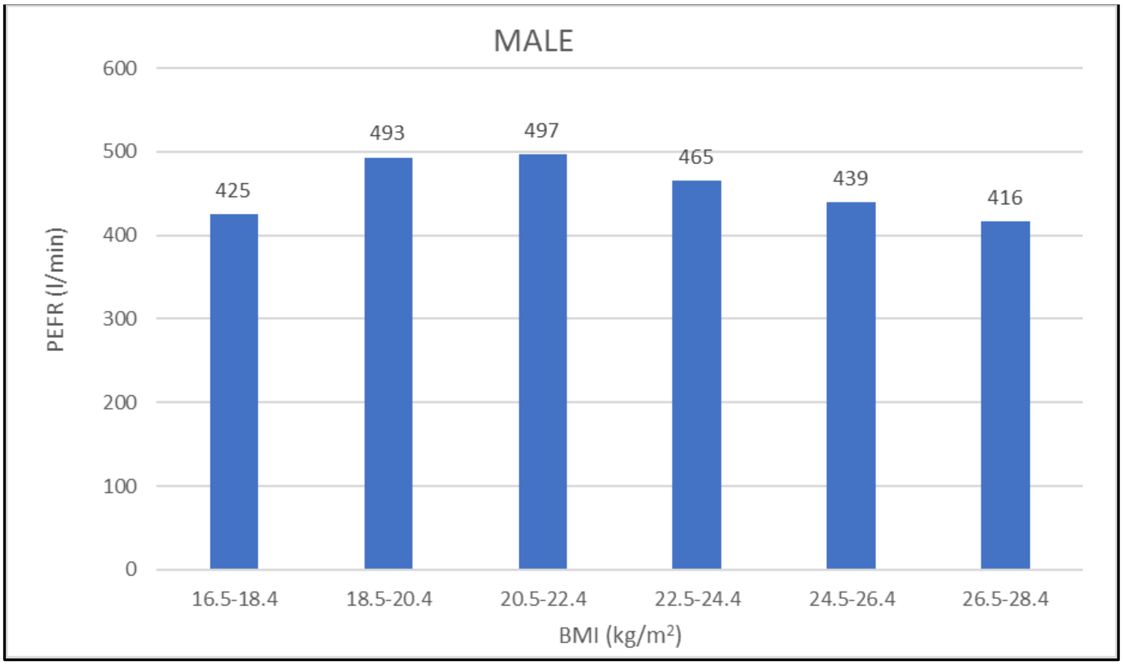


Figure 4 Bar diagram showing PEFR on the basis of body mass index (BMI)

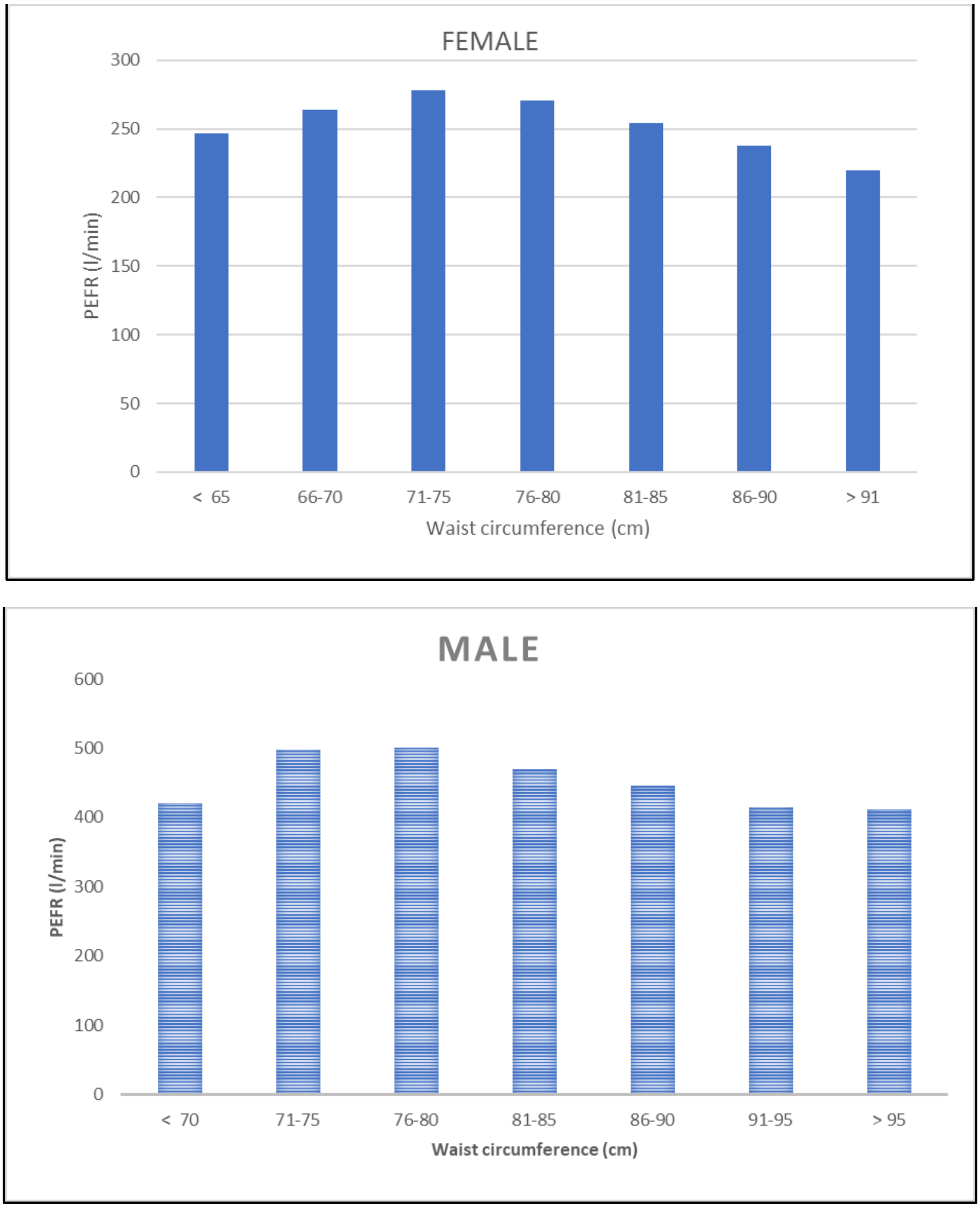


Figure 5 Bar diagram showing PEFR on the basis of waist circumference

4. Discussion

The present study was conducted to find out the impact of general and abdominal obesity markers on PEFR in college students having the age group 20-23 years. BMI was considered as overall obesity marker. According to WHO individuals with BMI < 18.5 kg/m2 are categorised as underweight, BMI between 18.5-24.9 kg/m2 as normal, BMI between 25.0 to 29.9 kg/m2 as overweight and BMI >30.0kg/m2 as obese. WC was used as abdominal obesity markers. Overall obesity is considered as predictors of pulmonary functional status whereas abdominal obesity influences pulmonary function mechanically by changing pulmonary compliance (5).

PEFR in males was significantly (p <0.001) higher than female. Height of males (167.06 ± 5.91 cm) was significantly (p < 0.001) higher than females (154.50 ± 5.72). Previous studies suggested that PEFR is directly correlated with height (16). A statistically significant (p< 0.001) correlation was found between height and PEFR when studied for combine data of both genders. Thus, higher PEFR in males may be due to higher height of them in compare with female counterpart. Babu 2015 (1) reported that in males PEFR is more than female due to higher height and muscle power.

PEFR values in obese individuals were significantly lower than normal weight individual among male and female participants. Previous studies also reported that PEFR insignificantly reduced in obese males (5) and females (17). Prasoona et al (18) suggested that PEFR in obese group significantly lower than persons with normal weight. Like obese PEFR was significantly lower in underweight individuals than normal weight group. The lower PEFR values in obese individuals may be due to extra fat that hampers the movement of chest or abdomen or movement of diaphragm. Obesity also influences upper airway tone and lung reflexes that affect central control of breathing (19).

Statistically significant positive correlation was observed between BMI and PEFR in underweight group, and significant negative correlation in overweight and obese group of both male and female participants. Negative correlation between PEFR and BMI was also reported by several studies (20, 21). Without considering body weight status PEFR insignificantly negatively correlated with BMI. In comparison with abdominal obesity indices (WC and WC: Ht) overall obesity indices (BMI) more strongly correlated with PEFR among college students. Similar pattern of correlation was reported by previous investigators (22). Thus, it may be suggested that PEFR increases with increasing BMI up to certain limit and decrease with further increase of BMI. Like BMI similar pattern of association was noted between PEFR and central obesity markers viz. WC and WC: Ht. From result of this study maximum PEFR was noted in group having BMI 20.5-22.4 kg/m^2 for both male and female participants. Considering waist to height ratio as obesity marker maximum PEFR was observed in group of females having ratio 0.47 to 0.49 and in male participants having ratio 0.44 to 0.46. Maximum PEFR was noted at Waist circumference 71-75 for female and 76-80 cm for male participants.

PEFR primarily depends on strength of expiratory muscle, the recoil pressure of the lungs, Compliance of thoracic cavity and airway resistence. High BMI increases pulmonary blood volume and closure of dependent airways which leads to decrease compliance of lungs and thoracic cavity as well as PEFR (23). An increasing level of obesity increase total respiratory resistance in healthy obese subjects. Increased abdominal obesity restricts descent of diaphragm into the abdominal cavity causes incomplete expansion of the chest cavity which leads to increase thoracic pressure. All these lead to the reduction of chest wall compliance and increase respiratory workload

Leptin is a type of adipokine secreted by adipocyte of adipose tissue. Expression of adiponectin, the most abundant anti-inflammatory adipokine in adipose tissue is markedly reduced and expression of leptin, a pro-inflammatory adipokine is increased in obese patients with asthma (24). Both high BMI and high serum leptin levels are strongly associated with asthma in adults (25). Thus, in obese the adipose tissue is functionally highly active which is reflected by the presence of subclinical inflammation (26). This inflammatory response seems to contribute lung function (27).

5. Conclusion

PEFR is affected significantly by variation of overall as well as abdominal obesity. With increase BMI above 22.5kg/m2 PEFR decreases among young male and females may be due to extra adipose tissue in chest wall and abdominal wall. Increase abdominal obesity (WC > 80 cm for male and >75 cm for female) decreases PEFR among college students owing to hampers movement of diaphragm. PEFR in obese significantly lower than non-obese counterpart irrespective to gender. Increased adiposity decreases respiratory compliance as well as PEFR leading to increase respiratory workload. Thus, subjects were advised to control body weight to minimize the risk of respiratory impairment including bronchial asthma.

Compliance with ethical standards

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Disclosure of conflict of interest

Authors have declared that no competing interests exist

Statement of ethical approval

Written ethical approval has been collected and preserved by the author(s).

Statement of informed consent

The study was non-invasive. The prior written permission of the Institutional authority was taken. The written informed consent was obtained from the study participants. Participants were informed that the data obtained from them would be kept confidential.

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