

## Original Research Article

# Association of peak expiratory flow rate with obese and overweight individuals

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## ABSTRACT

**Background:** The increasing number of overweight and obese individuals is a serious health problem worldwide. Growing evidence had clearly and consistently evidenced that obesity is an essential and direct predictor of respiratory function. Aim and objectives were to observe body mass index (BMI) based variations in respiratory parameter in overweight and obese individuals.

**Methods:** The study was carried out on 320 (18-28 years) subjects in district Dehradun of Uttarakhand, India. Different anthropometric parameters and respiratory parameter was measured by proper procedures.

**Results:** The anthropometric parameters weight and height were found statistically significant ( $p < 0.05$ ) among all subjects. BMI based and gender-based comparison of respiratory parameter were found statistically significant ( $p < 0.05$ ). The correlation of BMI with peak expiratory flow rate (PEFR) was found statistically very highly significant. The correlation coefficient ( $r$ ) between BMI with PEFR was found = -0.6, denotes partial negative correlation.

**Conclusions:** Our study concluded that with increased BMI the PEFR decreases, which signifies that there is broncho constriction due to various mechanisms like direct action of adipose tissue on the air ways via a decrease in luminal diameter of the air way and an increase in the probability of airway collapse.

**Keywords:** Respiratory, Obese, Anthropometric parameters, Body mass index

## INTRODUCTION

Obesity stands out as an emerging global public health challenge that is epidemically increasing in both developed & underdeveloped countries. According to the recent report, India ranks the second highest number of obese children in the world, with 14.1 million reported cases.<sup>1</sup> Obesity is the state of excess adipose tissue mass. The increasing number of overweight and obese individuals is a serious public health problem that has implications for society and healthcare systems on a global scale. The economic consequences of obesity and associated diseases are not limited to high medical costs but also include indirect or social costs such as decreased quality of life, problems in social adjustment, lost

productivity, disability associated with early retirement, and death.<sup>2</sup> The adverse effects of obesity to emerge in population in transition are hypertension, hyperlipidaemia and glucose intolerance and respiratory disorders.<sup>3</sup> Although not a direct measure of adiposity, the most widely used method to gauge obesity is the body mass index (BMI). Obesity is associated with a state of chronic systemic inflammation that is driven predominantly by the action of substances released by adipose tissue. Chronic inflammation is caused by activation of the innate immune system, which promotes a pro-inflammatory state and oxidative stress and a consequent systemic acute-phase response. Systemic inflammation may play a crucial role in the pathogenesis of various obesity-related complications, including respiratory

disorders.<sup>4</sup> The dysfunction of adipose tissue can induce systemic oxidative stress and lead to abnormal production of adipokines, which contributes to the development of obesity-related disorders. Furthermore, the level of oxidative damage biomarkers is increased in obese individuals and is directly correlated with BMI, percentage of body fat, and levels of triglycerides and low-density lipoproteins.<sup>5</sup> The accumulation of fat, particularly abdominal visceral fat, impairs antioxidant mechanisms.<sup>6</sup> Pulmonary function testing provides objective quantifiable measures of lung functions. Ventilatory pulmonary function tests are particularly useful in evaluation of patients with respiratory complaints, screening for presence of obstruction and restrictive lung diseases.<sup>7-10</sup>

## METHODS

The current study was carried from May 2019 to December 2019, at Patel Nagar, Dehradun in the Department of Physiology of Shri Guru Ram Rai Institute of Medical and Health Sciences under the umbrella of noble and idealist faculty. The research was carried out on 320 medical students both males and females between the ages of 18-28 years from various seasonal years of under-graduation. BMI grading of subjects was done according to WHO criteria.<sup>11</sup> It was developed by Adolphe Quetelet.<sup>12</sup> The study was ethically approved by the departmental ethical committee.

Body mass index (BMI) and its Interpretation was done as  $18.5 \leq$  underweight,  $18.5-24.99$  normal weight,  $25-29.99$  overweight,  $30 \geq$  Obese. The subjects were firstly divided into four broad groups based on BMI & each group had 2 subgroups on gender basis: group I-All (80) normal weight subjects (40) M & (40) F, group II-All (80) underweight subjects (40) M & (40) F, group III- All (80) overweight subjects (40) M & (40) F and group IV- All (80) obese weight subjects (40) M & (40) F.

**Table 1: The subjects were further divided into two broad groups (A & B) based on gender.**

Group A (160)	Group I M (40)	Group II M (40)	Group III M (40)	Group IV M (40)
Group B (160)	Group I F (40)	Group II F (40)	Group III F (40)	Group IV F (40)

### Subject selection criteria

Subject selection criteria were, all the subjects were physically, socially, mentally fit, all the subjects were nonsmoker, nonalcoholic and were not addicted to any habit-forming substance, subjects with cardiovascular disorders (like hypertension) and diabetes mellitus were excluded from the study, approval from college's ethical committee was taken, informed consent was taken from

all subjects, all subjects were made familiar with the method & equipment prior to test performed.

### Anthropometric parameters

#### Age

Age was calculated in years to the nearest birthday.

#### Height

Height was measured in centimeters (cms) using Stadiometer (Avery Pvt. Ltd.). Calibration of stadiometer was done using a standardized rod. Stadiometer was checked once in two weeks for any error.

#### Procedure

Subjects were instructed to stand straight on a flat surface with feet flat, heels almost together, arms at side and looking straight ahead. Heels, hips, shoulder blades and occiput pressing against the vertical bar then the slider were brought down to rest on the top of the head pressing the hair. The arrow accurately measured the height to an accuracy of  $\pm 0.5$  cm.<sup>13</sup>

#### Body weight

Body weight was recorded in kilograms, using digital weighing machine Crown electronic weighing machine. Procedure: The subject was made to stand upright on the scale wearing minimum clothing after taking off his/her shoes. The weight was recorded to an accuracy of  $\pm 0.1$  kg, the BMI of each subject was obtained mathematically using the formula called as Quetelet formula.<sup>12</sup>

$$\text{BMI} = \frac{\text{Body weight (kg)}}{\text{Height}^2 (\text{m}^2)}$$

### Measurement of respiratory parameters

#### Peak expiratory flow rate (PEFR)

The PEFR was recorded in L/min using mini-wright peak flow meter (Breathe-O-meter, as per EU Scale) by CIPLA, Cipla Mumbai Ltd.

#### Procedure

The subject was asked to stand in an upright position with the peak flow meter held horizontally in front of his/her mouth and allowed to take a deep breath. Further he/she was asked to close her lips firmly around the mouthpiece, making sure that no air leaks around the lips. The subject was asked to breathe out as hard and as fast possible and the reading indicated by the cursor on the peak flow meter scale was noted and the sequence was repeated thrice. The highest PEFR among three trials was recorded as the peak flow rate.<sup>14</sup>

The equipment (Breathe-O-meter's) was sterilized by time to time and individual to individual to maintain the health dimension of subjects.

### Statistical analysis

All the parameters recorded were analyzed using Microsoft excel Software.

### Test applied

Student's T-test, chi- square test and pearson's correlation test

### Significance criteria

Significance criteria were 1)  $p \text{ value} \geq 0.05$ =not significant # 2)  $p \text{ value} \leq 0.05$ -significant\*, 3)  $p \text{ value} \leq 0.01$ -highly significant\*\*, 4)  $p \text{ value} \leq 0.001$ -very highly significant \*\*\*

## RESULTS

### Anthropometric parameters of all subjects

Table 1 shows the mean±standard error of mean (SEM) of all the anthropometric parameters. The mean±SEM for age was  $20.57 \pm 0.91$  years, height was  $165.86 \pm 0.64$  cms,

weight was  $68.46 \pm 9.55$  kgs and BMI was  $21.78 \pm 3.32$  kg/m<sup>2</sup> respectively.

**Table 1: Anthropometric parameters of all subjects (n=320).**

Parameters	Mean±SEM
Age (years)	$20.57 \pm 0.91$
Height (cm)	$165.86 \pm 0.64$
Weight (kg)	$68.46 \pm 9.55$
BMI (Kg/m <sup>2</sup> )	$21.78 \pm 3.32$

### BMI based comparison of anthropometric parameters of all subjects

In Table 2 the mean±SEM of age and height for group I, II, III and IV have not shown any significance ( $p > 0.05$ ). The mean±SEM of weight and BMI for Group I, II, III and IV was found highly significant ( $p < 0.05$ ).

In Table 3 the mean±SEM of age and height for group I, II, III and IV was not found significant ( $p > 0.05$ ). The mean±SEM of weight and BMI for Group I, II, III M and IV M was found very highly significant ( $p < 0.05$ ). Overweight group and obese group i.e. II and IV ( $p < 0.05$ ) were highly significant ( $p < 0.05$ , but underweight group II was not found significant ( $p < 0.05$ ).

**Table 2: BMI based comparison of anthropometric parameters of all subjects (n-320).**

Parameters	Group-I (n – 80) Mean±SEM	Group-II (n- 80) Mean±SEM	Group-III (n-80) Mean±SEM	Group-IV (n-80) Mean±SEM	P value
Age (years)	$19.44 \pm 0.17$	$18.97 \pm 0.15$	$20.83 \pm 0.22$	$23.03 \pm 0.22$	$> 0.05$ #
Height (cm)	$165.59 \pm 1.22$	$164.25 \pm 1.01$	$165.59 \pm 0.97$	$167.67 \pm 1.07$	$> 0.05$ #
Weight (kg)	$60.68 \pm 1.15$	$47.14 \pm 0.68$	$74.18 \pm 0.95$	$91.86 \pm 1.06$	$< 0.01$ **
BMI (Kg/m <sup>2</sup> )	$21.86 \pm 0.19$	$17.39 \pm 0.19$ #	$27.11 \pm 0.09$	$32.77 \pm 0.22$	$< 0.001$ ***

**Table 3: BMI based comparison of anthropometric parameters of all male subjects (n-160).**

Parameters	Group- I M (n – 40) Mean±SEM	Group- II M (n – 40) mean±SEM	Group-III M (n – 40) mean±SEM	Group-IV M (n – 40) mean±SEM	P value
Age (years)	$19.73 \pm 0.26$	$18.93 \pm 0.19$	$21.35 \pm 0.34$	$23.2 \pm 0.36$	$> 0.05$ #
Height (cm)	$172.64 \pm 1.24$	$169.95 \pm 1.19$	$169.75 \pm 1.33$	$173.08 \pm 1.01$	$> 0.05$ #
Weight (kg)	$66.35 \pm 1.27$	$51.45 \pm 0.71$	$77.39 \pm 1.15$	$97.43 \pm 1.15$	$< 0.001$ ***
BMI (Kg/m <sup>2</sup> )	$21.97 \pm 0.26$	$17.79 \pm 0.07$ #	$26.93 \pm 0.2$ *	$32.62 \pm 0.3$	$< 0.001$ ***

**Table 4: BMI based comparison of anthropometric parameters of all female Subjects (n-160).**

Parameters	Group- I F (n - 40) Mean ±SEM	Group-II F (n - 40) mean ± SEM	Group-III F (n - 40) mean ± SEM	Group- IV F (n - 40) mean ± SEM	P Value
Age (years)	$19.15 \pm 0.21$	$19 \pm 0.23$	$20.33 \pm 0.28$	$22.95 \pm 0.31$	$> 0.05$ #
Height (cm)	$158.53 \pm 1.39$	$158.55 \pm 1.05$	$161.43 \pm 1.07$	$162.03 \pm 1.44$	$> 0.05$ #
Weight (kg)	$55.01 \pm 1.45$	$42.83 \pm 0.66$	$70.76 \pm 0.96$	$85.98 \pm 1.25$	$< 0.001$ ***
BMI (Kg/m <sup>2</sup> )	$21.75 \pm 0.27$	$16.99 \pm 0.13$ #	$27.21 \pm 0.2$ *	$32.9 \pm 0.33$	$< 0.001$ ***

### **BMI based comparison of anthropometric parameters of all female Subjects**

In table 4 the mean±SEM of age and height for Group I, II, III and IV was not found significant ( $p>0.05$ ). The mean±SEM of weight and BMI for group I, II, III and IV F was found very highly significant ( $p<0.05$ ).

### **Respiratory parameter of all subjects**

The mean±SEM for PEFR was  $338.94\pm18.2$  (L/min) for all subjects

### **BMI based comparison of respiratory parameter of all subjects**

In table 5 the mean±SEM of PEFR (L/min) for Group I, II, III and IV was found very highly significant ( $p<0.05$ ). The mean±SEM of MAP for Group I, II, III and IV was found significant ( $p<0.05$ ).

### **BMI based comparison of respiratory parameter of all male subjects**

In table 6 the mean±SEM PEFR (L/min) for Group I, II, III and IV was found very highly significant ( $p<0.05$ ).

### **BMI based comparison of respiratory parameter of all female subjects**

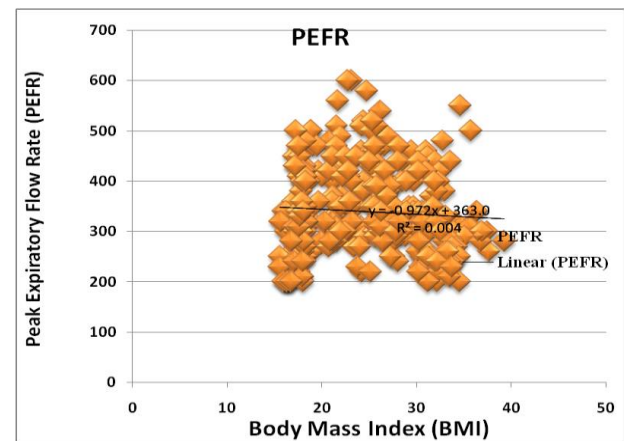
In table 7 the mean ±SEM of PEFR (L/min) for Group I, II, III F and IV was found very highly significant ( $p<0.05$ ).

### **Comparison of respiratory parameter in all male (group A, n - 160) and female (group B, n - 160) subjects**

In table 8 the mean±SEM for PEFR (L/min) of Group A and B subjects was found not significant ( $p>0.05$ ).

### **Correlation of BMI with PEFR**

The correlation coefficient (r) between BMI with PEFR was - 0.06, denotes partial negative correlation. The P-value between BMI & PEFR correlation was very highly significant ( $p<0.001$ ). This indicates there is a strong relationship between BMI with PEFR Figure 1).



$y = -0.972x + 363.0$ ,  $R^2 = 0.004$ , Coefficient of Correlation (r) = - 0.06

**Figure 1: Scatter diagram showing correlation between BMI and PEFR.**

**Table 5: BMI based comparison of respiratory parameter of all subjects (n-320).**

Parameters	Group- I n – 80 Mean ±SEM	Group- II n- 80 Mean ± SEM	Group-III n-80 Mean ± SEM	Group- IV n-80 Mean ± SEM	P value
<b>PEFR (L/min)</b>	382.13±9.98	312±9.19	355.75±7.92	305.13±8.65	0.001

**Table 6: BMI based comparison of respiratory parameter of all male subjects (n-160).**

Parameters	Group I M (n-40) Mean ±SEM	Group II M (n-40) Mean ±SEM	Group III M (n-40) Mean ±SEM	Group IV M (n-40) Mean ±SEM	P value
<b>PEFR (L/min)</b>	435.75±13.48	365.25±12.12	390.75±12.66	362.5±10.85	0.001

**Table 7: BMI based comparison of cardiovascular parameter of all female subjects (n -160).**

Parameters	Group-I F (n – 40) Mean ± SEM	Group-II F (n- 40) Mean ± SEM	Group-III F (n-40) Mean ± SEM	Group- IV F (n-40) Mean ± SEM	P value
<b>PEFR (L/min)</b>	328.5±8.64	260.25±7.36	320.75±5.56	297±5.96	0.001

**Table 8: Comparison of respiratory parameter in all male and female (group A and B) subjects.**

Parameters	Group A (n – 160 M) Mean±SEM	Group B (n-160 F) Mean±SEM	P value
<b>PEFR (L/min)</b>	388.56±6.53	301±4.05	0.001



## DISCUSSION

The increasing number of overweight and obese individuals is a serious health problem worldwide. Growing evidence had clearly and consistently evidenced that obesity is an essential and direct predictor of respiratory function. The main aim of this study was to observe variations in respiratory parameter with BMI in different groups. The data was statistically analyzed by using excel and applying Students t-test, chi-square test and pearson correlation Test. The study showed a partial negative correlation among respiratory parameter with BMI. On BMI based comparison the anthropometric parameters like weight & BMI were found statistically very highly significant in total number of subjects ( $p < 0.05$ ), whereas age and height were found not significant ( $p > 0.05$ ). Taking into consideration in all study subjects (n-320) the BMI based comparison of respiratory parameter showed statistically a positive significant association in various groups (Gr I, Gr II, Gr III & Gr IV). The parameter PEFR was found significant ( $p < 0.05$ ) in all subjects respectively. In total male subjects (n-160) the BMI based comparison of respiratory parameter was significant. PEFR was found statistically significant ( $p < 0.05$ ) in all groups of male subjects.

The gender-based comparison of respiratory parameter of Group A and B also showed positive association statistically. The parameter like PEFR were found to be very low significant statistically ( $p < 0.05$ ) in comparison of group A with group B. The BMI & gender-based comparison of respiratory parameters like PEFR between all groups (all male groups and all female groups), and showed very high significant ( $p < 0.05$ ).

Further it was observed that the correlation of BMI with PEFR was found to be statistically very highly significant. The correlation coefficient (r) between BMI with PEFR was found= -0.6, denotes partial negative correlation. Thus, the study showed that on increasing BMI the PEFR decreases.

Our results support the findings of Jena et al, Garg et al and Mafort et al as they showed that with increase in BMI, the PEFR decreases. He stated that subjects with high BMI have higher chance of bronchial asthma.<sup>15</sup> Garg et al study showed that PEFR substantiated with anthropometric & respiratory parameters can ascertain the level of physical fitness of given population & give a baseline idea of their pulmonary function in health.<sup>16</sup> Mafort et al showed that obesity causes mechanical compression of the diaphragm, lungs, and chest cavity, which can lead to restrictive pulmonary damage. Furthermore, excess fat decreases total respiratory system compliance, increases pulmonary resistance, and reduces respiratory muscle strength. It is interesting that metabolic syndrome also changes lung function and that the combination of obesity and metabolic syndrome seems to impair lung function even. In obese and overweight patients, a strong correlation exists between

lung function and body fat distribution, with greater impairment when fat accumulates in the chest and abdomen.<sup>17</sup>

This study has helped to make the students aware of their health status in the region of Uttarakhand and it will also benefit them as they have been volunteered to modify their lifestyle.

## CONCLUSION

The study demonstrated that BMI is closely associated with MAP. MAP is derived from the combination of standard measures of SBP and DBP. It allows description of BP as a single measurement. Our study concluded that on increasing BMI, the MAP was increased. The weight gain stimulates sympathetic activation, and also that probably insulin and leptin are involved. Also, activation of the rennin-angiotensin system as well as physical compression of kidney may be important factors in linking body weight and elevated blood pressure. Therefore, we counseled the subjects regarding the adverse effect of high BMI & maintain their weight by regular exercise and suitable diet pattern to live free of Respiratory disorders.

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## REFERENCES

1. Afshin A, Forouzanfar MH, Reitsma MB. Health effects of overweight and obesity in 195 countries over 25 years: the GBD 2015 Obesity Collaborators. *N Engl J Med*. 2017;377.
2. De Oliveira ML, Santos LM, da Silva EN. Direct healthcare cost of obesity in Brazil: an application of cost of illness method from the perspective of the health system in 2011. *PLoS One*. 2015;10:0121160.
3. WHO 2002. International Agency for Research on Cancer, IARC Handbooks of Cancer prevention-weight control and physical Activity, IARC Press, Lyon 2002.
4. Marseglia L, Manti S, D'Angelo G, Nicotera A, Parisi E, Di Rosa G, et al. Oxidative stress in obesity: a critical component in human diseases. *Int J Mol Sci*. 2014;16:378–400.
5. Fernández-Sánchez A, Madrigal-Santillán E, Bautista M, Esquivel-Soto J, Morales-González A, Esquivel-Chirino C, et al. Inflammation, oxidative stress, and obesity. *Int J Mol Sci*. 2011;12:3117-32.
6. Fonseca-Alaniz MH, Takada J, Alonso-Vale MI, Lima FB. Adipose tissue as an endocrine organ: from theory to practice. *J Pediatr*. 2007;83:192-203.
7. Naugler WE, Karin M. The wolf in sheep's clothing: the role of interleukin-6 in immunity, inflammation and cancer. *Trends Mol Med*. 2008;14:109-19.

8. Pedersen JM, Budtz-Jørgensen E, Mortensen EL, Bruunsgaard H, Osler M, Sørensen TI, et al. Late midlife C-reactive protein and interleukin-6 in middle aged danish men in relation to body size history within and across generations. *Obesity*. 2016;24:461–8.
  9. Stenlöf K, Wernstedt I, Fjällman T, Wallenius V, Wallenius K, Jansson JO. Interleukin-6 levels in the central nervous system are negatively correlated with fat mass in overweight/obese subjects. *J Clin Endocrinol Metab*. 2003;88:4379-83.
  10. Drougard A, Fournel A, Valet P, Knauf C. Impact of hypothalamic reactive oxygen species in the regulation of energy metabolism and food intake. *Front Neurosci*. 2015;9:56.
  11. Neeru G, Punam V, Nidhi J. Comparative Study of Pulmonary and Anthropometric Parameters in Females of Garwal. *Int J Contemp Medic Res*. 2016;3(7):2554-7379.
  12. Dharamshi HA, Faraz A, Ashraf E, Abbas A, Ali M. Variations of peak expiratory flow rate with body mass index in medical students of Karachi, Pakistan. *Int Arch Medic*. 2015;8(121):1-5.
  13. Wright BM, McKERROW CB (November 1959). Maximum forced expiratory flow rate as a measure of ventilatory capacity: with a description of a new portable instrument for measuring it. *Br Med J*. 2 (5159):1041-6.
  14. Quetelet LAJ (1871). *Anthropometrie ou Mesure des Differences Faculties de l'Homme*. Brussels: Musquardt.
  15. Tandon K. Obesity, its distribution pattern and health implications among Khatri population. Unpublished Ph. D. theses, Department of Anthropology, University of Delhi, Delhi. 2006.
  16. Neeru G, Punam V, Nidhi J. Comparative Study of Pulmonary and Anthropometric Parameters in Females of Garwal. *Int J Contemp Medic Res*. 2016;3(7):2554-7379.
- Thiago TM, Rogerio R, Claudia HC, Agnaldo JL. Obesity: systemic and pulmonary complications, biochemical abnormalities, and impairment of lung function. *Multidiscipli Res Medic*. 2016;11:28

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