Association of BMI, Peak expiratory flow rate and sympathetic reactivity in youth

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Abstract
Aims: Aim of this study, was to analyse the effect of Body Mass Index on PEFR and sympathetic and parasympathetic activity and to find which obesity marker has got better correlation with the autonomic functions.

Keywords: Body mass index (BMI), Obesity, PEFR, Sympathetic nervous function.

Introduction
Obesity is epidemic now a days and as defined by world health organisation it is a condition of excessive fat accumulation in the body to the extent that the health and wellbeing are adversely affect.[1] Obesity can also be defined as body mass index (BMI) $\geq$ 30 kg/m2. Obesity has become a very serious public health problem and it is replacing the other major causes of morbidity. The normal BMI range is between 18.5 and 24.99 kg/m2.

BMI generally considered as measure for obesity but waist hip ratio (WHR) and waist circumference (WC) are more acuurate marker for central obesity.[2] Sympathoadrenal system has major role in the development of obesity through regulation of energy expenditure.[3] Obesity results due to a disturbance in the energy balance. Major concerns of obesity are the comorbidities such as type 2 diabetes, cardiovascular disease, stroke and some carcinomas.[4] Weight gain along with metabolic events modify adaptation processes towards "resistance" of feedback involved in organ systems that ensure supply and utilization of energy.[5] Obesity can cause various deleterious effects to respiratory function, such as decrease in compliance, limitations in pulmonary function and exercise capacity. Obesity is also characterized by marked alteration in sympathetic reactivity such as heart rate, blood pressure. These changes are worsened by an increase in the BMI.[6] At more than 10-15% increase in body weight above the standard weight leads to significant decrease in response to sympathetic activity.[7] Obese person has less response to sympathetic stimulation and decrease receptors in white fat cells. Body weight and BMI can be easily measured and therefore are frequently used in large-scale epidemiologic studies.[8] BMI has been used for long as marker of obesity but it is found to lack sufficient explanation for Cardiovascular disorder so regional body habitus linked to obesity are WHR, WC used as a reliable measure for abdominal fat accumulation. There are confusing reports in obesity associated morbidity and mortalities. Rubinstein showed that obesity decrease function of respiratory system due to increase responsiveness of airway in adults,[9] while Young said it may be the cause of development of asthma.[10] While Schachter contradicted by stating that obesity had no role to play in respiratory function impairment.[11] Till now most of the studies related to pulmonary function & obesity was done either over children or adolescent age group or people above 50 years.[12] The age group of 16 to 25 years is crucial and highly susceptible for development of obesity was left in obesity related studies. Thus, in the present study we selected young adults of age 18 to 25 years to find the association between BMI (normal, overweight and obese) and PEFR status. PEFR was selected because of its acceptability as a reliable parameter and is simple to perform test. In this study we have analysed the effect of BMI on PEFR and sympathetic reactivity.

Materials and Methods
This study is a cross-sectional study, conducted at Department of Physiology, Narayan Medical College & Hospital, a tertiary care teaching hospital in Jamuhar, Sasaram in June 2019 after approval by the IEC, Institutional ethical committee. Sixty apparently healthy subjects, aged between 18-25 years were recruited in the study. They were classified according to WHO criteria[13] into 3 groups (normal, Overweight and Obese).
Group A (Normal)- 20 adults having BMI 18.5 -24.99
Group B (Overweight)- 20 adults having BMI 25-29.99
Group C (Obese) - 20 Adults having BMI>30.

Inclusion Criteria
Apparently healthy individual of age 18- 25yrs.

Exclusion Criteria
1. Age < 18 years and > 25 years
2. Fever or any other current illness
3. History of asthma, diabetes, hypertension and endocrinal disorder
4. History of any drug intake.
5. Immediate after exercise, meal or bath.
6. History of smoking or consumption of alcohol
7. Individuals with chest deformity
8. Recent upper or lower respiratory infections.

After taking detailed history from the participants, consent was taken, and the test procedure and objective were explained to them. Name, age, gender was recorded. Height and weight were measured using digital weighing machine

and stadiometer. The reading was taken at least 2 hours after breakfast and not immediately after exercise or any exertion. Body Mass Index (BMI) was calculated by Quetlet's Index, BMI = Weight (Kg)/Height^2 (Mtrs)

Waist Circumference was measured in erect posture & feet apart by 10 inch, by measuring tape at umbilicus. While Hip Circumference was measured at widest part of buttocks with feet together. From these values Waist Hip Ratio is determined.

PEFR was measured by spirometer model RMS Helios 702. (Accuracy: < +/- 5%; Repeatability: < +/- 5%) in the standing posture. The subjects were instructed to blow into the mouthpiece rapidly, forcefully and completely after maximum inspiration. They were trained well to blow into the instrument without any leak of air. Three measurements were recorded for each subjects at about five minute of intervals. The best of three values was taken into consideration. Thereafter non-invasive Autonomic Function Tests were performed. At least 10 minutes of rest was given between each test. Following tests were performed for Sympathetic function -

1. Resting heart rate
2. Resting Blood Pressure
3. Postural hypotension (Fall in systolic BP)
4. Sustained handgrip (Increase in diastolic BP)

Statistical Analysis

The obtained data were analysed using Microsoft excel 2013 and SPSS 26.0 software. The relationship between BMI and PEFR and between WHR and PEFR was calculated by using Pearson's coefficient. Then p-value is calculated and considered significant at $p < 0.05$.

Results

Anthropometric characteristics of the subjects are shown in the Table-1. Age, height, weight, BMI WC, HC and WHR were significantly different among all three weight group.

Table 1: Comparison of physical parameters among group A, B and C subjects

The BMI, WC, HC and WHR were significantly high in obese group C than overweight and normal (group B & A) subjects ($p < 0.0001$) (Table 1). However, PEFR was significantly less in Group C, obese person than other two groups ($p < 0.0009$)(Table 2).

There was a strong negative correlation between BMI and PEFR ($p < 0.0002$, r value –0.515). However, WHR and PEFR did not show any significant correlation ($p < 0.450$, r value –0.1201) (Table 3) (Fig.1)

As the table 4 shows, Resting heart rate was highest in obese and lowest in normal individual and the fall in systolic BP decreased with increase in weight as well as with increasing WHR. Increase in Diastolic BP (after sustained handgrip) went on increasing with increased weight. Resting Heart Rate has 'r' value of 0.34 for Sympathetic functions; fall in SBP after standing, had negative correlation with high BMI. (Fig. 2)

Table 1: Comparison of physical parameters among overweight, obese and normal weight subjects of study

	Normal Weight BMI 18.5-24.99	**Overweight BMI 25-29.9**	**Obese BMI≥30**	**P Value**
Parameters	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	
Number of participant	20	20	20	
Age (Years)	19.05 ± 1.23	19.05 ± 2.30	31.06 ± 0.94	0.0022
Height (cm)	172.9 ± 7.06	165.15 ± 8.20	164.1 ± 4.45	0.0002
Weight (Kg)	65.5 ± 8.79	72.7 ± 8.41	83.7 ± 5.39	<0.0001
BMI (Kg/m^2)	21.81 ± 1.58	26.56 ± 1.30	31.06 ± 0.94	<0.0001
Waist Circumference (cm)	73.83 ± 6.46	86.65 ± 7.77	99.10 ± 7.62	0.0001
Hip Circumference (cm)	91.35 ± 9.24	101.90 ± 13.39	107.79 ± 10.83	0.0001
Waist Hip Ratio	0.81 ± 0.05	0.86 ± 0.09	0.91 ± 0.08	0.0002
Anthropometric parameters (p<0.05 significant)				

Table 2: Comparison of pulmonary function tests in overweight, obese and normal weight subjects

	Normal Weight BMI 18.5-24.99	**Overweight BMI 25-29.9**	**Obese BMI≥30**	**P Value**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	
FVC (L)	3.68 ± 0.42	3.14 ± 0.73	3.15 ± 0.41	0.0090
FEV1 (L)	2.90 ± 0.33	2.36 ± 0.61	2.82 ± 0.30	0.0005
PEFR (L/min)	524.73 ± 63.36	487.68 ± 167.46	402.04 ± 94.89	0.0009
P<0.05- Significant				

Table 3: Correlation coefficient of BMI with PFT variables in obese subjects

	PEFR	P value
BMI	-0.515	0.020
WHR	-0.121	0.456
P<0.05- Significant		

Table 4: Correlation of BMI and WHR with Sympathetic activity

	BMI	P value	WHR	P value
Resting Heart Rate	0.34	0.0002	0.33	0.0001
Resting BP	0.31	0.0003	0.32	0.0002
Fall in SBP after Standing	-0.23	NS	-0.24	NS
Rise in DBP in sustained handgrip	0.32	0.0267	0.31	0.0252
P<0.05- Significant				

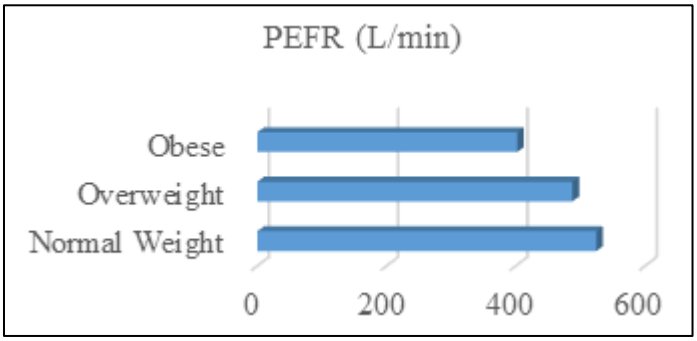

Fig. 1: Negative correlation of PEFR with BMI

Discussion

The present study showed that the PEFR significantly reduces in overweight (mean±SD 487.68±167.46) and obese subjects (mean±SD 402.04±94.89) when compared to normal weight subjects (mean±SD 524.73±63.36) and this shows negative correlation of BMI with PEFR in obese subjects. The result of the present study is in accordance with study done by Yogesh Saxena.[14] Various mechanisms are stated for such type of results. According to Naimark the compliance of lung and thoracic cavity was reduced to due to obesity-induced increase in pulmonary blood volume due to release of substance from fat cells and closure of lower airways. Excess trunchal fat also decrease compliance of thoracic cavity.[15] Rochester has find that obesity causes reduction of strength and power of respiratory muscles, so causing inefficient contraction that leads to impairment of respiratory function test.[16] PEFR depends on height, thoracic compliance and physical fitness which are higher in normal than in overweight and obese. In this study we find a negative correlation between BMI with PEFR. PEFR is inversely proportional to BMI. Jones et al also recorded the same finding in his study. He found that the increase in BMI is proportional to the reduction in PEFR.[18] There may be mechanical cause of reduction of PEFR by supressing airway. It compress the thoracic cavity leads to reduced vertical diameter of the thorax due to restriction of diaphragmatic movement. Thus it reduce compliance of lung and so the lung volumes and PEFR. When WHR is compared with PEFR, we found not any significant correlation. In contrast to this, Yogesh Saxena., and Chen reported a significant negative correlation between WHR & PEFR.[14,18] The reason for the difference may be described by the subjects selected for study. In our study the young adults are selected that has mild and developing obesity while they have selected older and persons of severe obesity. As far as autonomic function is concerned we found in this study that the activity of the human autonomic functions was inversely correlated with obesity. The study found that in sympathetic function, fall in SBP after standing decreased with increased BMI and Rise in DBP after sustained handgrip increased with increasing BMI (Fig. 2). On correlating BMI with Autonomic Function Tests (Table 4) it was found that Resting Heart Rate shows negative correlation with BMI. Peterson et al found lower sympathetic activity with increased body fat.[19] Kimura et al also found that autonomic function is severely compromised in obese subjects than non-obese subjects.[20] Visceral adipose tissue is the predominant adipose tissue component responsible for the production of cytokines and adipokines that is supposed to be the cause of derange autonomic reactivity and morbidity related to obesity. So, in today's world, where obesity is a pandemic, our concern should be focussed not only on the body weight but the composition too, as only body weight or BMI fail to differentiate between muscle and fat compartment.

Conclusion

In our study the results showed that increase in BMI and WHR had an inverse relationship with PEFR in obese when compared to the normal weight subjects. We also found that

sympathetic reactivity were decrease with increasing BMI and WHR. Thus it is evident from the present study that obesity significantly affects the pulmonary functions as well as sympathetic activity which may give rise to long term complications and may lead to early morbidity and mortality.

The non-pharmalogical intervention like dietary modifications (decrease fructose intake, iso-caloric diet), exercise and behavioural therapy (yoga) produce long term weight loss and moderate but clinically meaningful improvement in metabolic outcome. These measures may retain autonomic functions in optimum condition and improve respiratory compliance.

Limitation

More studies with larger sample size and considering life style along with measurement of visceral fat percentage and genetic factor may reveal other causes of impairment of autonomic functions related to obesity and development of prehypertension and hypertension.

Conflict of Interest: None.

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