Correlation of Body Mass Index, Body Fat percentage and Fat Free Mass Index with Autonomic Nervous Function

Swikruti Behera[1], Debasish Das[2]

ABSTRACT

Introduction: Obesity has several serious health implications. Autonomic nervous system is also affected in obese people. We have been using Body Mass Index(BMI) for long to assess obesity. But BMI does not differentiate between fat and muscle. Aim of our research was to study the effect of fat as Body Fat Percentage (BFP) and muscle mass as Fat Free Mass Index (FFMI) on Autonomic Function Test.

Material and methods: 77 apparently healthy male MBBS students were included in the study. Body composition was assessed using Bioelectric Impedance technique (Omron Body Fat Monitor) and Autonomic Function Test was done using non invasive computerised CANwin analysis apparatus.

Results: Result was analysed using GraphPad prism7.0 and Microsoft excel. The subjects were divided into 3 categories underweight, normal and overweight according to WHO criteria of BMI. Sympathetic functions were found to decrease with increasing BMI and parasympathetic function increased with increased BMI. Correlation of various autonomic functions with body composition parameters (BFP and FFMI) showed higher correlation than BMI.

Conclusion: So, we should aim to improve our body composition that is muscle mass and decrease out our body fat, not just weight to keep our autonomic function in optimum working condition.

Keywords: Body Mass Index (BMI), Body Fat Percentage (BFP), Fat Free Mass Index (FFMI), Sympathetic nervous function, Parasympathetic Nervous Function

INTRODUCTION

Obesity has become a very serious public health concern and it is replacing the other major causes health concerns as a significant contributor to ill health, as described by a WHO consultation.[1] Human obesity is characterized by marked sympathetic activation. A 10% increase in body weight above an individual's usual weight is accompanied with a decrease in parasympathetic activity.[2] Obese humans have decreased responsiveness to sympathetic stimulation and down regulated receptors in white adipose tissue. Gaining weight combines regularly with metabolic changes revealing adaptation processes towards "resistance" of feedback loops involved especially in organ systems ensuring supply and utilization of energy.[3]

Obesity results due to a disturbance in the energy balance. It is a prevalent disease in developed as well as developing countries. Major concerns of obesity are the comorbidities such as type 2 diabetes, cardiovascular disease, stroke and some carcinomas.[4,5]

Sympathoadrenal system is believed to play a major role in the pathophysiology of obesity through regulation of energy expenditure.[6,7]

Body Mass Index (BMI) has been used for long as surrogate marker of obesity. But Body fat percentage(BFP) and Fat Free Mass Index(FFMI) are more reliable markers as BMI cannot differentiate between fat and muscle mass.

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

MATERIAL AND METHODS

This study was conducted in Department of Physiology, MKCG medical college, Berhampur in the year 2012-13 after approval by the ethical committee. 77 apparently healthy MBBS male students aged between 18-24 years were included in the study. They were classified according to WHO criteria[8,9] into 3 groups (underweight, healthy and overweight). The group comprises of 12 underweight (BMI< 18.5), 34 Normal (BMI 18.5 -24.99) and 31 overweight (BMI 25-29.99)

Inclusion criteria

- Normal healthy males in the age group 18- 24 years.

Exclusion criteria

- Age < 18 years and > 24 years
- Fever or any other current illness
- History of asthma, diabetes, hypertension and endocrinal disorder
- History of any drug intake affecting blood pressure or heart rate.
- Immediate after exercise, meal or bath.
- History of smoking or consumption of alcohol.

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 Prestige digital weighing machine and stadiometer. Body fat percentage was recorded by Omron body fat monitor (HBF- 306). The reading was taken at least 2 hours after breakfast and not immediately after exercise or bath.

Body Mass Index(BMI) was calculated using Quetlet's Index

BMI = Weight (In Kilograms)/ {Height (In Metres)}^{2}

Fat Free Mass Index(FFMI) was calculated as

FFMI = {Weight (In Kg)-(BF% × Body weight)}/ {Height(In Metres)}^{2}

Modern autonomic function tests can non-invasively evaluate

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the severity and distribution of autonomic failure. Hence, non-invasive Autonomic Function Tests were performed using CANWin computerised autonomic nervous system Analysis system by 'Genesis Medical systems Pvt Ltd.' (CAN Analysis). At least 10 minutes of rest was given after each test. Following tests were performed -

- **Parasympathetic function**
  - Resting heart rate
  - Deep breathing - Avg deep breathing diff(DBD), Coeff of variation, Resp sinus Arrythmia Index (RSA index), Exp Insp Ratio(E:I)
  - Response to standing - Avg R-R Time Interval, Coeff of Variation, 30: 15 Ratio
  - Valsalva maneuver - Avg R-R Time Interval, Coeff of Variation, Valsalva Ratio
- **Sympathetic function**
  - Postural hypotension (Fall in systolic BP)
  - Sustained handgrip (Increase in diastolic BP)

STATISTICAL ANALYSIS

Microsoft office 2007 was used for the statistical analysis. Descriptive statistics like mean and percentages were used for the data interpretation.

RESULTS

All the results were analysed using Graph Pad prism 7.0. The mean and Standard Deviation were calculated in Table 1. Figures 1 and 2 were drawn using Microsoft excel to show the sympathetic and parasympathetic outcomes. Correlation was done and Pearson r value was calculated in Table 2 and the results are analysed ($p<0.05$). Table-1 illustrates the various antrhopometric parametres for underweight, normal and overweight.

Resting heart rate was highest in overweight and lowest in underweight. Deep Breathing Difference (DBD), Respiratory Sinus Arrhythmia Index (RSA Index) and E:I Index was lowest for overweight and is highest for underweight. R-R interval, 30-15 Ratio and Valsalva ratio increased with increasing weight (figure-1).

The fall in systolic BP decreased with increase in weight. Increase in Diastolic BP (after sustained handgrip) went on increasing with increased weight (figure-2).

Resting Heart Rate, DBD, RSA Index and R-R Interval has highest negative 'pearson r' value for body fat percentage (BFP) and lowest negative value for FFMI. 30:15 ratio and Valsalva ratio lowest correlation with BFP and highest with FFMI. Sympathetic functions; fall in SBP after standing, had highest negative correlation with FFMI and lowest with BFP. Rise in DBP after sustained handgrip shows highest 'pearson r' value for FFMI and lowest for BFP (table-2).

	Underweight (BMI <18.5)	Normal BMI (BMI 19-24.99)	Overweight (BMI 25-29.9)
Numbers	12	34	31
Age	19±0	19.2636±0.9920	18.925±0.997
Height	1.7475±0.024	1.696±0.05	1.693±0.063
Weight	51.25±1.936	57±4.847	80.259±10.414
BMI	16.545±0.625	19.873±2.06	27.866±2.044
BFP	13.424±0.75	17.478±2.522	26.993±2.419
FFM	44.352±1.273	46.933±2.958	58.376±5.876
FFMI	14.318±0.411	16.345±1.22	20.293±0.806

Table-1: Anthropometric parameters

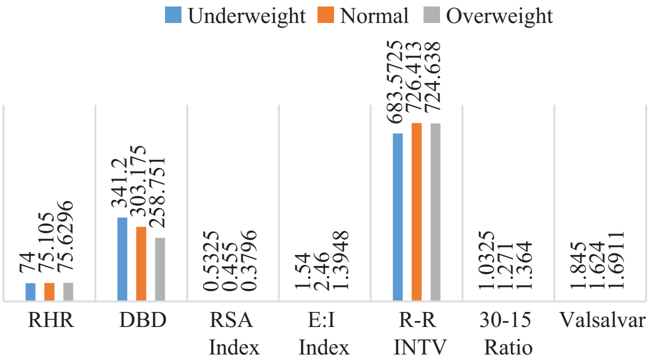

Figure-1: Parasympathetic

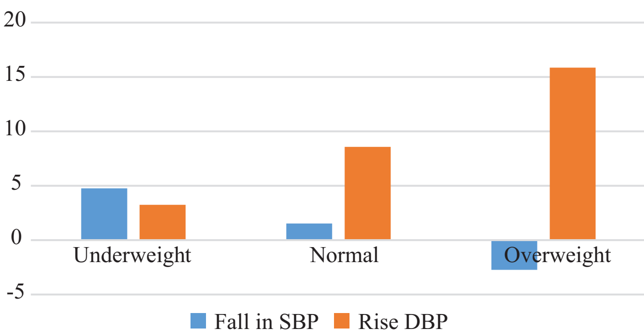

Figure-2: Sympathetic

	BMI	p value	BFP	P value	FFMI	P value
Parasympathetic						
Resting Heart Rate	0.3483	0.0002*	-0.6015	<0.0001*	0.6984	<0.0001*
DBD	-0.1542	Ns	-0.1784	Ns	-0.1763	Ns
RSA Index	-0.1873	Ns	-0.2106	Ns	-0.2004	Ns
E:I Ratio	-0.1861	Ns	-0.1995	Ns	-0.1858	Ns
R-R interval	0.0601	Ns	0.0600	Ns	0.1497	Ns
30:15 ratio	0.3789	0.0086*	0.3669	0.0112*	0.4083	0.0044*
Valsalva Ratio	0.00572	Ns	-0.0015	Ns	0.01086	Ns
Sympathetic						
Fall in SBP after standing	- 0.2316	Ns	-0.2314	Ns	-0.2491	Ns
Rise in DBP (after sustained handgrip)	0.3232	0.0267*	0.3142	0.0315*	0.329	0.0239*
(*significant, $p<0.05$)						

Table-2: Correlation of BMI, BFP and FFMI with various Autonomic Function Test.

DISCUSSION

Sympathoadrenal system is believed to play a major role in the pathophysiology of obesity through regulation of energy expenditure.[11] So, in today's world, where obesity is a pandemic, our concern should be focussed not only on the body weight only but the composition too as only body weight or Body Mass Index(BMI) fail to differentiate between muscle and fat compartment.

In this cross sectional study of 77 clinically healthy men with stable weights, we found that the activity of the human autonomic functions was inversely correlated with the body fat percentage. Fat Free Mass Index(FFMI) showed higher correlation coefficients for most of the sympathetic and parasympathetic function tests.

study found that the overweight (BMI = 25-29.9) have lower parasympathetic activity than non-obese (normal and underweight). In sympathetic function, fall in SBP after standing decreased with increased BMI and Rise in DBP after sustained handgrip Increased with increasing BMI (Figure 1 and 2). Kimura et al[12] and Chaudhuri et al[13] also found that obese subjects had significantly lower autonomic functions as compared to non-obese subjects.

On correlating BMI, BFP and FFMI with Autonomic Function Tests (Table 2) it was found that Resting Heart Rate shows negative correlation with BFP but positive higher correlation with FFMI than BMI. Average Deep Breathing Difference, RSA Index and E:I Index show highest negative correlation with BFP than BMI and FFMI. R-R Interval, 30:15 Ratio and Valsalva Ratio has highest positive correlation with FFMI. Parasympathetic Function tests have highest correlation with FFMI.

Several researchers like Bhorania et al[14], Colak et al[15] and Riva et al[16], have studied the relation of obesity with autonomic function tests using BMI as the reference parameter. But BMI does not differentiate between muscle and fat mass. So our study aimed at establishing the relation of body composition with different autonomic functions. We found that Body fat shows highest negative correlation whereas FFMI played a highest correlation among all three parameters.BMI has the lowest correlation out of these three parameters (BMI, BFP and FFMI). Bray GA[2], Peterson et al[17] found lower sympathetic activity with increased body fat. Yakinci et al[18] had found normal sympathetic nervous system and hypoactivity of parasympathetic nervous system in obese children.

CONCLUSION

In our study, we found the parasympathetic activity decreased with increased weight. Sympathetic function, fall in SBP after standing, decreased with increased BMI and Rise in DBP after sustained handgrip, Increased with increasing BMI. Body Fat Percentage (BFP) has highest negative or lowest positive 'Pearson r' with Parasympathetic autonomic function test. Sympathetic autonomic function, fall in SBP after standing, shows highest negative correlation with Fat Free Mass Index. Rise in DBP (after sustained handgrip) has highest positive 'pearson r' with FFMI.

Dietary modifications, exercise, and yoga to improve muscle amount and decreasing body fat percentage, may improve autonomic functions.

Further studies with larger samples of population including females as well, and measuring visceral fat percentage may prove to be more informative.

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