JMSCR Vol||05||Issue||07||Page 24967-24972||July [Year]

www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 83.27
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i7.109

IGM Publication Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Cardiac Vagal Tone and Anthropometric Parameters in Healthy Young Adults- Can Altered Cardiac Vagal Tone Predict Development of Obesity?

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ABSTRACT

Background: *This study was conducted to evaluate the effect of Cardiac vagal tone (CVT) on Body Mass Index (BMI) and Body fat percentage BFP) in healthy young adults.*

Methodology: *The study was performed on 121(males=59, female=62) healthy volunteers. The weight kg) and heightm) were measured and BMI was calculated. BFP was calculated using Durenberg equation. Cardiac vagal measures deep breathing difference DBD) and Valsalva ratio VR) were evaluated. BMI, BFP, DBD and VR were compared between both genders. The correlation between the anthropometric measures and CVT was determined by Pearson's/Spearman's correlation test. The effect of CVT on BMI and BFP was assessed by regression analysis.*

Results: *BMI was lower in females, whereas BFP was lower in males. No significant difference was found in the measures of cardiac vagal activity between the genders. A significant negative correlation was found between BMI and DBD(r= -0.367); Body fat percentage and DBD(r=-0.330) in males. Also, a significant negative correlation was found between cardiac VR and BMI(r= -0.317); VR and BFP(r=-0.290) in males.No such correlation was found in females. Regression analysis showed CVT predicts BMI and BFP in males.*

Conclusion: *The present study concluded that BMI and BFP are associated with CVT in healthy young males and CVT predicts the development of obesity in healthy young males.*

Keywords-*Body Mass Index, Body Fat Percentage, Cardiac Vagal tone.*

INTRODUCTION

Changes in lifestyle, dietary patterns and various environmental factors, genetic factors have resulted in increased prevalence of obesity [1].

Overweight and obesity are the leading risk factors for development of cardiovascular disease (CVD). It accounts for 23% of the ischemic heart disease burden[2]. Large prospective studies such as the Framingham Heart Study, have shown that overweight and obesity are associated with increased risk of CVD [3]. Obesity is known to be associated with increased risk of diabetes, hypertension, dyslipidemia and coronary artery disease [4]. Prevalence of obesity among young adults in developing countries range from 2.3 to 12 %, with over weight as high as 28% [5]. Increasing trend of obesity in young adults has been noted in last decade.

Obesity develops due to long term imbalance between energy intake and energy expenditure. Several factors like physical activity level, hormones and autonomic nervous system (ANS) play important role in the pathophysiology of obesity through regulation of energy expenditure [6]. The relationship between ANS and obesity is complex. Studies have shown association between low sympathetic activity and development of obesity [7,8]. It is also observed that obesity alters the activity of ANS. A 10% increase in body weight above an individual's usual weight causes a decrease in parasympathetic tone and increases the sympathetic activity [9].

Body Mass Index (BMI) has been used as surrogate marker of obesity. But Body fat percentage (BFP) is considered to be a more reliable marker, as BMI cannot differentiate between fat mass and muscle mass. Cardiovagal domain of ANS can be assessed by evaluating heart rate responses during deep breathing manoeuvre and Valsalva manoeuvre [10]. Deep breathing test evaluates the parasympathetic functions whereas Valsalva manoeuvre evaluates the CVT using heart rate responses [11].

Only few studies have evaluated the effects of alterations in parasymapathetic limb of ANS on body weight. Existing studies support the fact that cardiac vagal tone(CVT) varies inversely with markers of obesity, research studies of CVT in healthy young non-obese individuals (BMI <30kg/m2) and its effect on BMI and BFP are sparse. We hypothesized that, a reduced CVT may anticipate the development of obesity in otherwise non-obese healthy adults. This study aimed to analyse the effect of CVT on BMI and BFP and to evaluate its role in gender specific prediction of development of obesity in young adults.

MATERIALS AND METHODS

This was a cross-sectional study involving 121(59 males, 62 females) healthy adults between the ages of 18 and 25 years. Subjects with acute illness in preceding two weeks, Diabetes mellitus, hypertension or other medical illness requiring treatment habitual use of tobacco and alcohol were excluded. Volunteers were requested to refrain from strenuous physical activity for 24hours, and any food or beverages for 2 hours prior to recording. Female volunteers performed experimental protocol between the 5th to 10th day of menstrual cycle to avoid confounding factors related to hormonal factors. Ethical clearance was obtained from Institutional Ethics and Research Committee and all the tests were performed after obtaining written informed consent from volunteers. The anthropometric parameters like weight [kg], and height[m] were measured using digital weighing scale, and stadiometer, respectively. The BMI was calculated from weight divided by height squared. Body fat percentage was calculated using Durenberg equation [12]. Following 15 minutes of rest, tests to assess cardiac parasympathetic function were performed. Resting heart rate was recorded using R-R interval of Lead II ECG. Resting baseline blood pressure was recorded. Simple tests based on the measurement of ECG derived heart rate responses to physiological perturbations of cardiovascular function were performed. These includes: Heart rate response to deep breathing – Deep Breathing Difference (DBD) and Heart rate response to Valsalva Manoeuvre – Valsalva ratio (VR). These tests were performed using Labscribe software.

Heart rate responses to deep breathing manoeuvre was performed by connecting ECG electrodes for recording lead II ECG and respiratory belt transducer for recording chest movements. After obtaining, baseline recording for 30 seconds, deep breathing manoeuvre was performed.

Subject was instructed to breathe (inhalation and exhalation) at a slow and steady rate taking about 5 seconds each for inhalation and exhalation for at least six complete respiratory cycles. The ECG, thus obtained was analysed for maximum (HR max) and minimum heart rate (HR min) for each respiratory cycle, for six respiratory cycles. Difference between HR max and HR min was calculated for each cycle and mean of this difference was noted as DBD. A value > 16 was considered to be normal.

Following 30 minutes of rest, heart rate responses to Valsalva manoeuvre was performed by asking the subject to blow into the mouthpiece (flange between the teeth, lips enclosing mouth piece, nose closed by nose clip), attached to the pressure transducer. After initial 30 seconds of recording in resting state, the subject was instructed to blow into mouthpiece with an open glottis, such that the intrathoracic pressure rises rapidly to 40 mmHg and remains steady at that level for at least 15 seconds. After 15 seconds of steady pressure at 40 mmHg, subject was asked to release the pressure and continue breathing naturally. Recording was continued for 45 seconds after release of pressure. The maximum heart rate during the manoeuvre and minimum heart rate following the manoeuvre was noted. The ratio between the same was calculated. Valsalva Ratio >1.45 was considered to be normal.

Statistical analysis: The data obtained were analysed using SPSS version 19.0 software. Data was expressed as Mean ± SD. Association between anthropometric parameters, vagal tone parameters among either gender was performed using independent t test. All vagal tone parameters were normally distributed except DBD in females and VR in both genders. After log transformation DBD normally distributed. Therefore parametric tests were used to analyse data of females. However, in males, VR remained same even after log transformation, hence; Spearman's correlation test was used. Regression analysis was performed to predict the relation of changes in parasympathetic tone and cardiovascular risk. P < 0.05 was taken as statistically significant.

RESULTS

Data from 121(59 males, 62 females) was utilised for analyses. Mean age of the study population was 19.18±1.15 years.

Table 1 shows anthropometric parameters and cardiovascular parameters among either gender. There was significant difference in height, weight, BMI and BFP between males and females. Height, weight and BMI were significantly lower in females. However, BFP was significantly higher in females when compared with males. There was no significant difference in resting cardiovascular parameters between males and females. Difference among vagal tone parameters i.e. Deep breathing difference (DBD) and valsalva ratio (VR) among males and females was not found to be significant.

Table 1: Anthropometric Parameters and Cardiovascular Parameters

Variables	Mean ± S.D	
Anthropometric Parameters		
	Male[n=59]	Female[n=62]
Age(years)	19.39±1.86	18.97±1.14
Height(m)*	1.70 ±0.93	1.60±0.06
Weight(kg)*	66.59±12.64	53.44± 7.97
BMI(kg/m2)*	23.05±3.39	20.81± 2.68
Body fat percentage*	15.96±4.01	23.79±3.23
Cardiovascular Parameters		
Resting Heart rate [beats per minute]	69.36±11.23	74.48±13.82
Resting SBP[mmHg]	114.67±8.36	112.07±7.59
Resting DBP[mmHg]	67.67±6.15	65.27±4.50
DBD	29.32±10.80	28.83±11.95
VR	1.81±3.30	1.74±0.32

BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, DBD: Deep Breathing Difference, VR: Valsalva Ratio *Significant p-value< 0.05

Table 2 shows correlation between cardiac vagal measures and anthropometric parameters among males and females. There was significant negative correlation between DBD and Fat percentage in males Also, there was significant negative correlation between DBD and BMI in males. A negative correlation was found between VR and body fat percentage, BMI in males. There was no significant correlation between vagal tone parameters and anthropometric parameters among females.

Regression analysis was carried out to assess whether vagal tone as assessed by deep breathing and VR contributes to BMI and BFP in males (Table 3). DBD was found to have significant impact on BMI and BFP in males. Cardiac vagal measure VR was also found to statistically significantly predict BMI and BFP.

Table 2: Correlation between cardiac vagal measures and anthropometric parameters

	DBD		VR	
	Male r-value	Female r-value	Male r-value	Female r-value
BMI	-0.377*	0.748	-0.317*	-0.142
BFP	-0.339*	0.723	-0.290*	-0.142

*Significant p-value <0.05

As no significant correlation was found between the markers of CVT and anthropometeric measures in females, regression analysis was not carried out.

Table 3: Regression analysis of BMI & BFP (dependable variables) with DBD and VR 9independent variables) in males

Variables	Standardised regression coefficient B	t-value	P-value
Regression analysis of BMI and BFP with DBD in males			
BMI	-0.377	-3.076	0.003
BFP	-0.339	-2.272	0.009
Regression analysis of BMI and BFP with VR in males			
BMI	-0.317	-2.163	0.008
BFP	-0.290	-2.457	0.004

BMI: Body Mass Index, BFP: Body Fat Percentage, DBD:Deep Breathing Difference, VR:Valsalva Ratio.
p-value < 0.05 significant

DISCUSSION

This is a cross sectional study among healthy volunteers of either gender. The results of present study suggested that in apparently healthy non-obese males the CVT is inversely associate with BMI and BFP. In present study the baseline characteristics showed that, height, weight and BMI was significantly higher in males. A cross sectional study that mainly assessed the association between anthropometric parameters and cardiovascular risk among young adults showed that, height, weight, waist circumference, hip circumference were found to be higher in males as compared to females [13]. Similar findings were found by a study, which showed that, the trend of overweight and obesity was more among males [14]. Although BMI was more in males, the BFP estimated by any standard technique is more among females when compared with males [15]. These findings are in line with the results of our study. Lower BFP among males may be attributed to greater lean body mass in them, that results in the greater BMI [16].

It is well recognized that, cardiovascular responses of blood pressure, cardiac output, heart rate, and other variables to change in posture, breathing manoeuvres differ between genders. Several studies have found a significant difference in the cardiac autonomic activity between males and females of younger population [17,18]. Several studies on gender based differences in resting CVT have provided conflicting results. Some studies have shown increased cardiac vagal modulation in females [17-19] while some have showed no such differences [20,21]. In the present study no significant difference was found in CVT between males and females. It is well established fact that young women are at lesser risk of developing hypertension and coronary artery disease than men of same age. This is attributed to the differences in cardiac autonomic modulations between the genders. Though in present study cardiac sympathetic modulation was not assessed, a recent study found no gender differences in cardiac vagal parameters in healthy volunteers, whereas it reported higher sympathetic activity in males compared to females [22]. The higher sympathetic tone in males can be attributed to the higher incidence of hypertension and coronary heart diseases in men.

In present study a significant negative correlation was found between BMI and CVT as assessed by DBD and VR in males. Also, a negative significant correlation was found between BFP and measures of CVT (Table 2). These findings suggest an association between CVT and anthropometric parameters in healthy young non-obese males. Previously, studies have evaluated the effect of BMI on vagal tone. A study assessed the influence of gender and BMI on vagal tone among adult population of mean age 38 years. It concluded that, among males, BMI had significant negative correlation with parasympathetic activity than females of same age group [23]. Our study findings are in agreement with the studies that have found a lower vagal tone in obese individuals [24]. Present study showed no correlation between cardiac vagal tone and anthropometric measures in females.

The outcomes of present study, give impression that decreased CVT plays a vital role in the shift of anthropometric measures from normal to overweight state in young males. Furthermore, measures of CVT emerged as significant contributor to BMI and BFP in young healthy males(Table3). The findings of this study suggest that, even in healthy young men, it is possible to identify the individuals with higher tendency to develop obesity by assessing CVT using simple tests like DBD and VR and take appropriate preventive measures.

CONCLUSION

This study demonstrated that cardiac vagal tone is associated with BMI and Body fat percentage in healthy young males and cardiac vagal tone predicts BMI and body fat percentage in healthy young males.

AKNOWLEDGEMENTS

The investigators, staff and participants of the study are gratefully acknowledged.

Declarations: None
Funding: None
Conflict of interest: None

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