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Research article

A STUDY OF CORRELATION OF ANTHROPOMETRIC PARAMETERS AND HEART RATE VARIABILITY AMONG MEDICAL STUDENTS IN SOUTH INDIA

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ABSTRACT

Background: Obesity is known to cause a number of life style diseases. In spite of this, the developed and developing world is faced with increasing number of people with high Body fat. In the present study we evaluated the correlation of Heart rate variability with the anthropometric parameters depicting body fat among young students recruited from our Medical school.

Materials and methods: Two hundred and forty medical students (120 males & 120 females) were selected on the basis of their BMI into four groups: viz. Normal (N), Underweight (UW), Overweight (OW) & Obese (OB), [n=30 each]. Their Lean Body Mass (LBM), W/H ratio were calculated and tabulated, their HRV was recorded for 5 minutes and both time domain and frequency domain analysis was done.

Results: The body fat was significantly higher in OW and OB groups as reflected in increased W/H ratio and lower LBM. ($p<0.001$) and significantly lesser in the UW group. But women showed significantly more W/H ratio and lesser LBM compared to men in the same group ($p<0.01$). Cardiac autonomic control represented by HRV showed significant reduction in the OW and Obese groups ($p<0.01$). HRV parameters were significantly lower in Underweight subjects when compared to Normal subjects.

Conclusions: The HRV parameters showed a sympathetic predominance as the body fat increases. Females showed higher Body fat content compared to men. Therefore the treatment strategy should involve in weight reduction and diet control in vulnerable subjects and sustained physical exercise regimen may be prescribed to prevent the possible cardiovascular and endocrine disorders which they are prone.

Key words: BMI, LMB, Waist hip ratio, Heart rate variability

INTRODUCTION

The Obesity is considered a widespread health problem which has close correlation with the modern life style. Obesity reduces life expectancy and can lead to varied health problems.(Okorodudu DO, et al., 2010; Haslam DW, James WP., 2005). Most of the cases of obesity are due to diet, sedentary lifestyle and a small percentage could be attributed to either genetic or metabolic disorders. (Lau DC., et al., 2007; Bleich S. et al., 2008)Body mass index (BMI), waist Hip ratio and Lean Body mass are the parameters which are used as a measure of obesity.(Sweeting HN, 2007; Gray DS, Fujioka K., 1991) Waist hip ratio is the preferred measure of obesity for predicting cardiovascular diseases. The National Institute of Diabetes, Digestive and Kidney Diseases (NIDDK) states that women with waist–hip ratios of more than 0.8, and men with more than 1.0, are at increased health risk because of their fat distribution.(Fisher ML, Voracek M. 2006).

The close correlation between abdominal obesity and autonomic derangement may partially account for the higher risk of mortality and morbidity in subjects with obesity.(Lahti-Koski. Et al., 2007). It appears that in old age, autonomic control of heart becomes weak; Sachidananda G et al.(2011) from our Institution, concluded that the heart rate variability decreases with increase in waist hip ratio in geriatric population.

Further, the degree of decrease in sympathetic activity occurred earlier than that in the parasympathetic activity in geriatric population with higher waist hip ratio. Significantly lower HF normalized units and higher LF normalized units in the supine position was reported in Obese adolescents, obesewomen with BMI<30and men. **(**Brunetto AF et al.2005Guizar JM. et al., 2005, Taylor et al. 2001). TascilarME et al. (2001) also reported that obese children showed a significant decrease in HRV in both time-domain and frequency-domain parameters, which implied parasympathetic withdrawal and sympathetic predominance. RMSSD was associated with lower levels of lean body mass, subcutaneous abdominal adipose tissue, resting heart rate, resting systolic blood pressure, and exercise hear rate. (Gutin B, et al., 2000).

The close correlation between body adiposity and Autonomic activity represented by HRV has been reported byStrong et al. found that a high level of parasympathetic activity is related to less adiposity in youth (Strong W, et al., 2005) and a high level of parasympathetic activity was associated with lower body mass index and thinner skin folds in males and females.(Raitakari O, et al., 1997). In the present study we present the data which assessed the effect of anthropometric variabiles, namely LBM, W/H ratio, BMI on cardiac autonomic activity in young healthy males and females aged 18-22 years, in order to assess the risk of cardiovascular disease.

MATERIALS AND METHODS

This cross sectional study was conducted in our medical school in south India, among a total of 240 young medical students in the age group of 18- 22 years. In this study a detailed history of subjects was taken followed by physical examination, vital signs, complete systemic examinations. A twelve lead electrocardiogram was recorded. An informed written consent of all the participants was taken after explaining the method of study.

The Time Bound Research Ethics Committee approval was taken before conducting the study.

INCLUSION CRITERIA

Subjects of this study will be male and female young adults of age 18-22 years.

EXCLUSION CRITERIA

History of congenital heart diseases, thyroid disorders. Pregnant women, Smokers, alcoholics and drug abusers, Diabetes mellitus, Subjects on antihypertensive.

List of parameters studied:

A) Anthropometric parameters:

1. Height 2.Weight 3. Body Mass Index.

4. Waist- hip ratio (W/H) 5.Lean body mass (LBM)

B) Heart rate variability (HRV)

METHOD OF STUDY

Anthropometric parameters calculated were BMI from Height & weight, W/H ratio was calculated from waist & hip measurements. LBM was calculated by Lean body mass = Total body weight – body fat in lbs. the body fat was calculated by the skin fold estimation method, based on skin fold test whereby a pinch of skin is precisely measured by calipers at several standardized points on the body to determine the subcutaneous fat layer thickness as mentioned elsewhere. These measurements are converted to an estimated body fat percentage with the help of an online calculator. The skin fold sites are triceps, biceps, shoulder blade and waist. ECG was recorded bystandard 12 lead ECG machine with jelly and electrode. A high quality ECG recording was taken under standardized condition to minimize artifacts. The ECG signal is first analog recorded and then digitally converted. Analysis of this in the time domain and frequency domain was done. Digital Data Acquisition system: HRV soft 1.1 VERSION, AIIMS, NEW DELHI.

They were instructed to be as relaxed as possible and to breathe spontaneously at their own rate. The procedure was explained to the subject. After a resting period, the subjects ECG were recorded in the supine position during normal breathing for 5 minute. After this a break of 2 minute was given. Then the next ECG recording was taken during deep breathing for 1 minute.The subject was asked to inspire for the first 5 seconds from the count of 1 to 5 and expire the next 5 seconds from the count of 5 to 1.This recording was taken for 6 such cycles i.e. one minute. The male (120) & female (120) participants are recruited as per WHO classification according to BMI (Quetelets index) (Park K. 2009) in to 4 categories (n=30 each) on the basis of calculated BMI; and heart rate variability was assessed. Mean BMI of these groups were as in the table 1.

Table 1.Mean BMI ± SD of each group selected for the study.

Males: (120)	Females: (120)	Mean
Under weight (UW)	17.4±1.04	18.05±0.39
Normal (N)	21.2±1.85	23.49±1.35
Overweight (OW)	26.95±1.36	28.10±1.25
Obese (OB)	33.3±2.41	35.57±0.76

STATISTICAL ANALYSIS OF DATA

The statistical analysis was done by using SPSS (Statistical Package for Social Sciences) version 11.5. ANOVA (Analysis of variance), student's unpaired t test, and Tukey's test was done and p value was taken as significant at 5 percent confidence level ($p<0.05$).

RESULTS AND ANALYSIS

Table 2: Anthropometric parameters in Under weight (UW), Normal (N), Overweight OW) and Obese (OB) male & female subjects as per BMI. (N=120)

Males (120)	W/H ratio(Male)	W/H ratio(Female)	LBM(Male)	LBM(Female)
UW	0.76±0.07***†††	0.71±0.05	90.91±4.6***†††	82.4±3.66
Normal	0.83±0.05	0.78±0.04	81.41±4.15	70.30±3.44
OW	0.93±0.08 **†††	0.99±0.12 ***,†††	77.46±4.60 **†††	67.03±3.16 ***,†††
OB	1.11±0.21 ***†††	1.54±0.49***,†††	67.67±5.12 ***†††	59.95±4.62***,†††

Values Mean±SD; * Normal Vs Other Gr; † OW Vs OB *,† = p<0.05; **,†† = p<0.01; ; ***,††† p<0.001

The anthropometric parameters among the four groups were compared with each other and found to be highly significantly different. In Overweight and Obese subjects, the Waist Hip ratio was significantly more than the Normal subjects. However there was significantly more W/H ratio among OB Women compared to men. The LBM was significantly more in Under weight ($p<0.01$) Subjects and progressively lesser in OW and OB subjects ($p<0.001$).

Table 3 : Heart rate variability during Normal Breathing in Under weight (UW),Normal(N), Overweight(OW) and Obese(OB) male subjects as per BMI.

MALES (120)	p NN50	RMSSD	SDANN	LF	HF	LF/HF ratio
UW	22.6± 18.1***†††	38.3± 6.73***†††	44.4±8.03†††	44.2±6.87*** †††	50.1±8.00*** †††	0.91±0.22
N	30.9 ± 5.00	53.2±12.6	72.2±8.32	57.56±8.01	59.3±4.96	0.97±0.14
OW	25.02±3.07	46.4±6.02*††	63.8±4.4***† ††	46.89±8.49 * * *	51.61±8.87 ***	0.91±0.41
OB	17.5± 5.13 ***†††	36.9±5.95 ***†††	48.14±5.13 ***†††	35.84±8.63 ***†††	41.9±7.63 ***†††	0.82±0.26 □

Values Mean ±SD; N vs other groups *, †UW vs other groups, OW, OB

†,* p<0.05 significant (S), ††, **p < 0.01 highly significant, ††† *** p <0.001 very highly significant (VHS)

HRV among the male subjects, showed statistically significant decrease in time domain analysis namely pNN50, RMSSD, SDANN, and frequency domain analysis LF, HF including LF/HF ratio in obese groups when compared among the groups (ANOVA, p<0.001). There was a significant decrease in RMSSD, SDANN, and LF in obese groups when compared to Overweight groups (p<0.001). Overweight group showed least pNN50, RMSSD, SDANN, and LF when compared to all other groups. The Underweight group also showed significant decline in pNN50, RMSSD, SDANN, but the values of time domain (LF, HF) analysis were comparable with that of over weight subjects.pNN50 values of OW group vs UW group did not show statistical difference.

Table 4: Heart rate variability during Normal Breathing in under weight (UW), Normal (N), Overweight (OW) and Obese (OB) Female subjects as per BMI

Female	p NN50	RMSSD	SDANN	LF	HF	LF/HF ratio
UW	23.26±3.6***	38.43±6.1***	59.86±8.71***	46.09±4.84***	52.04±6.33***	0.89±0.14
N	27.85±5.3	46.15±4.47	67.09±3.10	52.75±12.15 □□	61.88±5.89	0.86±0.20
OW	22.12±4.6 ***	38.62±4.03 ***	62.70±3.23 **	43.85±7.29 ***	55.90±7.64 **	0.80±0.18
OB	20.70±3.49 ***	34.37±3.29 *** †††	57.44±4.05 ***†††	39.11±4.97 *** ††	51.8±8.27 ***	0.77±0.15

Values Mean ±SD; *N vs other groups, †UW vs other groups, OW vs OB

† * p<0.05 significant; **††p<0.01 highly significant; †††*** p <0.001 very highly significant.

Among the female subjects HRV showed a significant decrease in both time domain and frequency domain analysis Viz. pNN50, SDANN, LF and HF compared to normal subjects. Overweight and Obese females showed lower values compared to normal & UW groups. Under weight group too showed significantly less HRV parameters.

DISCUSSION

This cross sectional study was conducted in our Medical University (n=240) All subjects were aged between 18-22 years. Though the study group was small, this pilot study reflected the trends in HRV correlation with anthropometric parameters namely BMI, LBM, W/H ratio among young adults.The subjects were selected on the basis of their BMI. Thirty of them fitting to four groups, viz. Normal, Under weight (UW), overweight (OW)& Obese (OB)were recruited (Table 1). In our study group, Waist Hip (W/H) ratio was found to be highest in Obese and lowest in Underweight subjects (Table 2). W/H ratio has been acknowledged as an important measure of Body fat. Several previous studies in adults have reported a stronger positive association between cardiovascular risk factors such as hypertension, and lipid and glucose concentrations, and W/H than with overall adiposity as measured by BMI, although BMI has also been reported as being one of the most important risk factors for type 2 diabetes (Haffner S, et al., 1992; Richelsen B. et al., 1995; Zhu S, et al., 2002).

In the present study, though W/H ratio of normal and under weight subjects were significantly lesser than the OW & Obese groups the female subjects showed significantly higher W/H ratio. This finding shows that females may have higher abdominal fat content than men. This is also reflected in significantly lesser Lean Body Mass (LBM) among females, compared to men (Table 2). Moreover, LBM progressively decreased when the level of obesity increased The study report by Gortmaker SL (1990) showed that decreases in physical activity reduce LBM and lower energy requirements. Thus the present results obtained were in agreement with the previously published articles. Obese and overweight subjects had a lower HRV (Table 3 & 4).We observed a reduction in time domain analysis, pNN50, SDANN (ms) and RMSSD (ms). This was true for the women group too. Thus the study confirms the high prevalence of alterations in HRV in obese individuals as shown in earlier studies on obese children, adolescents and adults.(Kaufman CL, et al., 2007; Guízar JM et al., 2005). Time-domain measures of heart-rate variability, SDANN reflect both sympathetic and parasympathetic modulation of heart rate and reduced SDANN values usually indicate relative sympathetic dominance. And Time-domain measures of heart-rate variability, SDANN reflect both sympathetic and parasympathetic modulation of heart rate and reduced SDANNvalues usually indicate relative sympathetic dominance.(Lombardi F. 2002). Frequency domain indices indicating lower parasympathetic activity in obese young adults.

The exact mechanism that may cause impairment of parasympathetic nerve function has not yet been clearly established. Obesity is said to be a state of impaired glucose tolerance, hyperinsulinemia and insulin resistance. Acute insulin administration has been shown to reduce high-frequency power, a measure of respiratory sinus arrhythmia, during euglycemichyperinsulinemia in normal-weight and obese subjects.(Van de Borne P. et al., 1999; Muscelli E, et al., 1998). Thus, hyperinsulinemia may contribute to low cardiac vagal activity (Valensi P, et al., 2005)

In our study LF (nu), HF (nu) showed significant reduction in obese male and female groups when compared to normal weight groups (p<0.001). But LF/HF ratio does not show any significant change in male and female obese groups. The LF/HF ratio has been proposed to be an accurate measure of the overall sympatho-vagal balance of the autonomic nervous system in which higher values indicate a more sympathetically driven cardiovascular system.(Kaufman CL, et al., 2007; Malliani A, et al., 1997). Insulin and leptin levels are elevated in obesity (Guízar JM, et al., 2005)

In the present study there was a significant increase in LF modulation (increase in sympathetic modulation) males when compared to female groups. This means that the male population has an overall higher sympathetic drive than women. Higher sympathetic activity has been related to a higher susceptibility to fatal arrhythmia and to the development of coronary artery disease (Schwartz PJ, et al., 1992) Therefore, hypothetically, the reduced LF power in women could protect against the development and incidence of coronary artery disease and arrhythmia. The exact contribution of this difference in autonomic cardiac control remains to be elucidated.

There appears to be a strong correlation between the Obesity levels measured in terms of BMI, LBM and W/H ratio and the heart rate variability, reflecting sympatho-vagal balance on heart. Obese persons may suffer from an increased mortality risk due to cardiovascular disorders related to either continuously lowered parasympathetic or altered sympathetic activation. Early detection and management by weight reduction and regular exercise can reduced the risk as these are shown to increase HRV. (Sandercock GR, et al., 2005)

Lifestyle approaches like reduced-calorie consumption, High lean body mass, and weight loss approaches usually result in considerable loss of both fat and improve lean body mass. (Garrow JS, et al., 1995; Kraemer W J, et al., 1999). Less carbohydrates in diet and increased exercise helped maintaining LBM. (Volek JS, et al.2002). Heart rate variability analysis can detect changes even before clinical signs appear. Thus regular assessment of Heart rate variability measures can be used as a biomarker for early detection and subsequent management of cardiovascular diseases in obese individuals.

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