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Comparative study of heart rate variability in obese and normal young adults in medical college

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Abstract

Introduction: Obesity is a condition from which the body has an excess accumulation of fat, which may cause from current daily routines and activities such as overeating and/or lacking of exercise. According to the International Association for the Study of Obesity (IASO), the International Obesity Task Force (IOTF) and the World Health Organization (WHO) proposed, BMI cut-points 23.0 to 24.9 kg/m² for being overweight and above 25.0 kg/m² for obesity in adult Asians. Nutritional problem in India is shifting from undernourishment to obesity. The autonomic nervous system plays an important role, not only in physiological situations, but also in various pathological settings such as diabetic neuropathy, myocardial infarction and congestive heart failure.

Materials and Method: This study consists of 100 healthy young adults and 100 subjects in the age group of 20-26 years selected from the patient attendants and medical students of Santosh Medical College and Research Centre, Ghaziabad. Anthropometric parameters like height and weight were recorded. Body Mass Index (BMI) was calculated. They were categorized as Cases (n=100) and Controls (n=100) based on the BMI, Controls whose BMI < 25 kg/m² and Cases with BMI > 30 kg/m². Subject was explained in detail about the ongoing procedure and ECG was digitally recorded after 10 minutes rest using lead II.

Results: The mean age of the controls and cases were 22.16 and 21.82 respectively. Our study results showed significant inverse relationship between BMI and HRV parameters like SDNN, E/I ratio and HF nu, but at the same it showed significant positive relation of BMI and LF nu, LF/HF.

Discussion: This study is a novel part of the on-going long-term epidemiological Cardiovascular Risk in Young Finns study. Many studies into lifetime cardiovascular risk profiles in this study population have been reported previously. In 2003, Raitakari *et al.* demonstrated that cardio metabolic risk profile assessed in 12-year to 18-year-old adolescents predicts adult carotid artery intima-media thickness (cIMT) independently of contemporaneous risk factors. This study is an effort to assess the effect of obesity on cardiac autonomic activity using Heart Rate Variability in young adults as sudden cardiac death in later ages can be prevented if life style modifications can be brought in earlier.

Conclusion: The present findings demonstrate decreased HRV is associated with age, male gender and increased heart rate. Women have higher HF variability and lower LF variability than men, higher sympathetic and lower parasympathetic nerve activity in obese subjects. The results show that the HRV is decreased in overweight young adults especially men indicating sympathovagal imbalance. Changes in the autonomic nervous activity begin in the overweight and may become more prominent in the obese thus indicating increased cardiovascular risk. HRV indices were significantly associated with obesity indices.

Keywords: Heart rate variability, obese, normal young adults

Introduction

Obesity is a condition from which the body has an excess accumulation of fat, which may cause from current daily routines and activities such as overeating and/or lacking of exercise^[1]. According to the International Association for the Study of Obesity (IASO), the International Obesity Task Force (IOTF) and the World Health Organization (WHO) proposed BMI cut-points 23.0 to 24.9 kg/m² for being overweight and above 25.0 kg/m² for obesity in adult Asians^[2].

Nutritional problem in India is shifting from undernourishment to obesity^[3]. It is a condition, which has involved with the advent of civilization, sedentary life style and high calorie diet^[4]. Obesity is one of the causative factors for multiple co-morbid conditions leading to metabolic and cardiac disorders^[5]. Growing number of evidences indicate association of obesity and sudden cardiac deaths^[6, 7]. Obesity is accompanied with varied combinations of abnormalities in the autonomic nervous system.

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One view is that obese people have a higher sympathetic tone that has been proved in some studies correlating with the catecholamine levels. But there is also evidence of reduced cardiac sympathetic tone in some studies which was partly explained on the duration of obesity [8].

The autonomic nervous system plays an important role, not only in physiological situations, but also in various pathological settings such as diabetic neuropathy, myocardial infarction and congestive heart failure. Autonomic imbalance with increased sympathetic activity and reduced vagal tone has been strongly implicated in the pathophysiology of development of arrhythmias and sudden cardiac deaths [9-11]. Among the different available non-invasive techniques for assessing the autonomic status, Heart Rate Variability (HRV) is a simple method to evaluate the sympathovagal balance at the sinoatrial level [12]. Heart Rate Variability (HRV) is a specific and sensitive noninvasive tool to evaluate cardiac autonomic activity. HRV is the degree of variation of the heart rate under the balanced influence of sympathetic and parasympathetic components of the cardiac autonomic nervous system. HRV also indicates the extent of neuronal damage to autonomic nervous system [13].

It is shown that in obese people, there is reduction in the HRV reflecting a predominant sympathetic influence on control of cardiac functions. HRV studies among adults and children with obesity have revealed inconsistent results including high and low sympathetic tones coupled with a reduction in vagal tone [14-16]. It has also been shown in western studies on obese adults that weight loss reverses back to parasympathetic control of cardiac functions [17]. While there are evidence of significant changes in autonomic control of cardiac functions in obese children and adults, there is lack of information concerning changes in obese young adults and also studies regarding HRV in obese Indian population are very few. Hence present study was under taken with the aim of evaluating the resting cardiac autonomic nerve activity given by the changes in HRV analysis in healthy obese young adults.

Materials and Method:

This study consists of 100 healthy young adults and 100 subjects in the age group of 20-26 years selected from the patient attendants and medical students of National Institute of Medical Sciences & Research, Jaipur. Anthropometric parameters like height and weight were recorded. Body Mass Index (BMI) was calculated. They were categorized as Cases (n=100) and Controls (n=100) based on the BMI. Controls whose BMI < 25 kg/m² and Cases with BMI > 30 kg/m². Subject's clinical history and details were taken according to the standard proforma. Informed written consent was taken from all subjects in the study. Subjects with major illness like diabetes mellitus, hypertension, endocrinal disorders and on any drugs affecting the Autonomic Nervous System like adrenergic blockers, calcium channel blockers, others were also excluded.

Subject was explained in detail about the ongoing procedure and ECG was digitally recorded after 10 minutes rest using lead II. First, a 5 minutes ECG in supine position was recorded, with subject breathing normally and used to determine the SDNN LF, HF and LF/HF. Then, the person was periodically instructed to take alternating 5 seconds of deep inspiration and 5 seconds of deep expiration for a period of 2 minutes and simultaneous ECG was recorded.

This data was used to measure the E/I ratio.

Heart Rate Variability software, was used in the computer, to detect the peak to peak intervals and further mathematical and analytical calculations in order to get the values of the parameters.

Results

The mean age of the controls and cases were 22.16 and 21.82 respectively.

Table 1: Shows there was a statistically significant increase in BMI in cases when compared to controls. ($p < 0.001$)

Variables	Control Mean	Cases Mean	'p' Value
Age (years)	22.16	22.94	0.158
BMI (Kg/m ²)	24.34	31.36	<0.001

Table 2: Shows significantly reduced SDNN, E/I ratio, HF nu in cases when compared to controls suggesting the reduction in the parasympathetic activity. Significant increase in LF nu and LF/HF ratio shows elevated cardiac sympathetic activity in obese individuals. ($p < 0.01$)

HRV	Control Mean	Cases Mean	'p' Value
SDNN(ms)	105.24	42.47	<0.01
E/I ratio	1.76	1.40	<0.01
LF _{nu}	40.13	72.64	<0.01
HF _{nu}	61.38	29.13	<0.01
LF/HF	0.68	3.26	<0.01

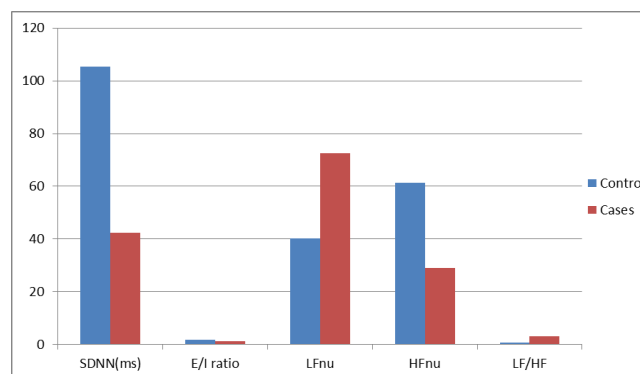


Fig 1: Comparison between control and cases

Our study results showed significant inverse relationship between BMI and HRV parameters like SDNN, E/I ratio and HF nu, but at the same it showed significant positive relation of BMI and LF nu, LF/HF.

Discussion

This study is a novel part of the on-going long-term epidemiological Cardiovascular Risk in Young Finns study. Many studies into lifetime cardiovascular risk profiles in this study population have been reported previously. In 2003, Raitakari *et al.* demonstrated that cardiometabolic risk profile assessed in 12-year to 18-year-old adolescents predicts adult carotid artery intima-media thickness (cIMT) independently of contemporaneous risk factors. These findings suggested that exposure to cardiometabolic risk factors early in life may induce changes in arteries that actually contribute to the development of atherosclerosis.¹⁸ Humans vary in their responsiveness to environmental stressors and HRV measurements may serve as physiological markers for such variation [19]. During normal sinus rhythm, the heart rate varies from beat to beat. Heart rate variability (HRV) results from the interplay between the

various physiological mechanisms that regulate the heart rate. Since short-term heart rate regulation is predominantly governed by sympathetic and parasympathetic neural activity, by examination of heart rate fluctuations normal functioning of the autonomic nervous system can be tested. HRV has been used as a measure of autonomic balance that emanates from endogenous sympathetic and parasympathetic rhythms which are partly modulated by respiratory sinus arrhythmia [20, 21]. There are different measures of HRV— Time domain indices, Frequency domain indices and also non-linear techniques. Time domain analysis of heart rate variability uses statistical methods to quantify the variation of the standard deviation or the differences between successive RR intervals. Frequency domain analysis of heart rate variability enables us to calculate the respiratory dependent high frequency variations [12, 22].

This study was conducted to excess the effect on cardiac autonomic activity in healthy young adults 20-26 years. The major findings of this study indicate the presence of impaired parasympathetic activity and elevated level of sympathetic activity in obese group. When parasympathetic activity is considered there is not much difference among the studies, as almost all of the studies show a significant reduction in the parasympathetic activity with increasing body weight, which were similar to our studies [23-26]. In contrast to our study some studies showed a significant reduction in the sympathetic activity. This variation among the studies was partially explained on the basis of the duration of obesity [27]. It has been said that duration of the obesity has a major role to play in determining the level of cardiac sympathetic activity [28]. Correlation analysis between the obesity indices and HRV indices in this study showed that the time domain indices of HRV was significantly correlated negatively with overall obesity measured by BMI and WSR than the central obesity measured by WC, HC and WHR. In frequency domain indices LF component and LF/HF ratio were positively correlated whereas HF component was negatively correlated with both overall as well as central obesity indices. BFP was also negatively correlated with overall HRV and HF component which was not significant. There was also weak positive correlation between BFP and LF component, LF/HF ratio. Age and sex matched regression analysis showed that BMI was the major determinant for the changes in both time domain and frequency domain indices. WSR was the next important predictor for the time domain indices whereas for the frequency domain indices it was WC and WHR.

Early detection and management by weight reduction and regular exercise can reduced the risk as these are shown to increase HRV [29, 30]. HRV analysis can detect changes even before clinical signs appear. Thus regular assessment of HRV measures can be used as a biomarker for early detection and subsequent management of cardiovascular diseases in obese individuals.

This study is an effort to assess the effect of obesity on cardiac autonomic activity using Heart Rate Variability in young adults as sudden cardiac death in later ages can be prevented if life style modifications can be brought in earlier.

Conclusion

The present findings demonstrate decreased HRV is

associated with age, male gender and increased heart rate. Women have higher HF variability and lower LF variability than men, higher sympathetic and lower parasympathetic nerve activity in obese subjects. The results show that the HRV is decreased in overweight young adults especially men indicating sympathovagal imbalance. No changes were observed in HRV in underweight group. Changes in the autonomic nervous activity begin in the overweight and may become more prominent in the obese thus indicating increased cardiovascular risk. HRV indices were significantly associated with obesity indices. BMI was the major determinant for the changes in both time and frequency domain indices. Thus time and frequency domain analysis of the HRV in obese young adults shows imbalance in the autonomic neural activities to the heart.

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