

Original article:

A study of heart rate variability in young obese individuals

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Abstract

Introduction: Obesity is a nutritional health problem and pro inflammatory condition that increases cardiovascular morbidity and mortality risk. Heart rate variability (HRV) test is considered as an early tool to evaluate the integrity and functional state of autonomic nervous system that controls the heart.

Aim and objectives: The aim of this study is to assess and compare the heart rate variability in young obese individuals and the normal individuals so that cardiovascular risk can be assessed earlier.

Materials and methods: This cross sectional study was conducted on a group of 50 young obese individuals with BMI > 25 and 50 individuals with normal BMI as controls in the age group of 18 to 25yrs. Resting heart rate variability test was done using Nivique Digital ECG Recorder. Student's t test was employed for statistical analysis

Results: The LF/HF ratio was increased in the obese group 1.42 ± 0.59 when compared to the control group 0.72 ± 0.29 ($P < 0.001$) which implies sympathovagal imbalance in the young obese individuals.

Conclusion: HRV tests in young obese individuals indicate definite autonomic dysfunction in the form of sympathetic over activity and parasympathetic withdrawal. Early identification helps to prevent adverse cardiovascular events

Keywords: Heart rate variability, young obese, autonomic imbalance

Introduction

Obesity is a nutritional health problem that has reached an epidemic proportion in our society. This is considered to be due to the development in socioeconomic status with advent of civilization, leading to change in life style especially in dietary pattern ^[1]. Present environment of excessive food availability and intake as compared to decreased physical activity favors an increase in adiposity. Thus an excessive intake of calories in relation to energy expenditure which is termed as positive energy balance, over a long period of time leads on to obesity ^[2]. World Health Organization documents state that 312 million people are obese worldwide ^[3].

Obesity is a pro inflammatory condition that increases cardiovascular morbidity and mortality risk by various mechanisms ^[4, 5, 6]. Obesity is associated with alterations both in hemodynamics and metabolic activity. Obese people have higher prevalence of co-morbidities like hypertension, hyperlipidemia, coronary heart disease, Type 2 diabetes mellitus, Sleep Apnea Syndrome, osteoarthritis, fatty liver, polycystic ovarian disease and neoplasms. Obesity forms a part of the metabolic syndrome, dyslipidemia, hypertension, insulin resistance who have a higher risk for cardiovascular diseases ^[7]. Early studies indicate that obesity is associated with sudden cardiac deaths ^[8,9]. Hence obesity is considered as a leading preventable cause of death worldwide.

The resting Heart rate variability is a non- invasive test to evaluate the integrity and functional state of autonomic nervous system (ANS). Animal studies have shown that HRV is considered a marker of vagal activity. Greater heart rate variability implies that the heart adapts more quickly and flexibly to internal and external influences due to an optimum interplay between the PNS and SNS. Lower heart rate variability indicates a reduced ability for adaptation which in turn may suggest autonomic dysfunction leading to serious health impairment ^[10]. This test is simple, non- invasive, easy to perform and reproduce. HRV is considered as an early tool that reflects distress. It is an early warning sign of alteration in the autonomic neural control of the heart rate. Therefore in this study, the autonomic activity of young obese individuals was assessed by resting HRV test so as to detect the autonomic imbalance early and adverse cardiac effects could be prevented by early life style modification.

Aim and Objectives:

To evaluate the resting Heart rate variability in young obese individuals and compare with the normal individuals and to correlate the HRV indices with obesity indices in young obese individuals

Materials and methods:

This cross sectional study was conducted at Madras Medial College, Chennai, in the Institute of Physiology and Experimental Medicine, after obtaining the Institutional Ethics Committee clearance. The study was conducted on a group of 50 young obese individuals with BMI > 25 in the age group of 18 to 25yrs of both sexes and 50 age matched normal individuals with normal BMI. The study included equal number of males and females. 25 males and 25 females in the control group and 25 males, 25 females in the young obese group that is a total of 100 participants were included in the study. Subjects with any medical illness i.e. respiratory and heart failure and renal disease, hypothyroidism, anemia , diabetes, hypertension, pregnancy, post- partum period, use of any medications, glucocorticoids, oral contraceptives or any hormonal therapy within the previous 6 months were excluded.

Height and weight of the subjects were measured and BMI calculated using Quetelet's index, $BMI = \text{Weight in Kg} / \text{Height in meter square}$. After selection of subjects, an informed, written consent was obtained from the study group and also the control group. After taking a detailed history, their Waist circumference (WC) and Hip circumference (HC) were measured and their Waist Hip Ratio (WHR) was calculated as $\text{Waist circumference} / \text{Hip circumference}$. A thorough general as well as systemic examination was done. The subjects were made comfortable and relaxed without any significant anxiety. The test was performed in a quiet room, lighting subdued and with controlled, comfortable temperature ranging from 25-28°C. The subjects were made to rest quietly for a minimum period of ten minutes, without moving, in the awake and supine position. Resting Heart rate variability test was done using Niviqure Ambulatory Digital ECG Recorder.

Niviqure ECG recorder is a digital, solid state, stand alone, multi load computerized recording system. It is designed to acquire ECG, analyze it and store the ECG data over long hours. The data is acquired and it is stored in flash memory. The data can be later downloaded and further analysis done as per the recommendations of Task Force, 1996 ^[11]. The transfer of data from the flash memory module to the computer is via an interface RS232C which is a compatible module. Niviqure has powerful processing software for online ECG study, for storage of data and off line data replay and study. The data can be transferred to other software for statistical analysis and Fast Fourier Transformation (FFT) analysis ^[12].

Exploring electrodes were placed in the left and right shoulder, left subcostal region. Reference electrode was placed in right subcostal. During this resting period, ECG was acquired for five minutes (320 seconds), by a continuous recording which is required for short term ECG analysis. The ECG data is screened for any artifact. After editing it, the results were fed to HRV analysis software. The analogue to the digital conversion of the resting ECG signal was done with sampling frequency of 1024/sec using AD converter. The converted ECG signal was analyzed under power spectrum using Fast Fourier Transformation (FFT) analysis.

Time domain measures Standard deviation of Normal to Normal intervals (SDNN), Mean HR, and frequency domain measures normalized Low frequency (LF nu), normalized High frequency (HF nu), LF /HF ratio were all estimated. The values are compared with normal values obtained from the control group. Using the Statistical Package for Social Sciences (SPSS) software version 21, all the data obtained were analyzed using unpaired student's t test.

Results:

The age, height and obesity indices of the controls and obese groups were compared. Table - 1 shows that P value of age and height were not significant. The difference in weight, BMI, WC, HC, WHR were very highly significant (p <0.001)

Table – 2 shows that SDNN in the control group was 60.14 ± 15.50 and that in the obese was 52.20 ± 8.39 . There was a highly significant decrease of standard deviation of normal to normal interval (SDNN) in the obese group with a p value of 0.002. The Mean HR in the obese group was raised with a very high significance (p<0.001). The LF nu in the controls was 40.47 ± 9.58 and in the obese was 56.21 ± 10.95 , with very highly significant increase in the obese (P <0.001). The HF nu in the controls was 59.46 ± 9.13 with a highly significant decrease in the obese 43.86 ± 11.12 (P <0.001). The LF/HF ratio which is an accurate measure of sympathovagal balance has increased in the obese group (1.42 ± 0.59) when compared to the control group (0.72 ± 0.29) with a very highly significant P value of <0.001.

Table – 3 shows that Pearson's correlation of HRV parameter LF /HF ratio has positive correlation with obesity indices BMI and WC

Table – 1 Comparison of physical characteristics and obesity indices between cases and controls groups

Variables	Controls (n=50)	Cases (n=50)	P-value
Age (years)	20.10 ± 1.05	20.38 ± 2.18	0.4163
Height (m)	1.60 ± 0.06	1.58 ± 0.07	0.179
Weight (kg)	52.42 ± 2.58	78.86 ± 5.62	<0.001***
BMI	20.48 ± 1.09	31.50 ± 2.25	<0.001***
WC (cm)	75.26 ± 1.91	106.30 ± 5.37	<0.001***
HC (cm)	93.90 ± 4.0	107.34 ± 5.81	<0.001***
WHR	0.80 ± 0.04	0.99 ± 0.02	<0.001***

*** Very highly significant

Table – 2 Comparison of Resting HRV indices - Time domain measures and Frequency domain measures between cases and control groups

Variables	Controls (n=50)	Cases (n=50)	P-value
SDNN	60.14 ± 15.50	52.20 ± 8.39	0.002**
MEAN HR	74.30 ± 2.79	77.06 ± 4.18	<0.001***
LF nu	40.47 ± 9.58	56.21 ± 10.95	<0.001***
HF nu	59.46 ± 9.13	43.86 ± 11.12	<0.001***
LF/HF RATIO	0.72 ± 0.29	1.42 ± 0.59	<0.001***

** Highly significant

*** Very highly significant

Table – 3 Pearson’s Correlation of HRV index (LF/HF) with BMI and WC

HRV- LF/HF ratio	BMI	WC
‘r’	0.59**	0.57**
‘r’ is Pearson’s correlation coefficient ** p<0.01		

Figure 1 Comparison of LF nu and HF nu between controls and cases

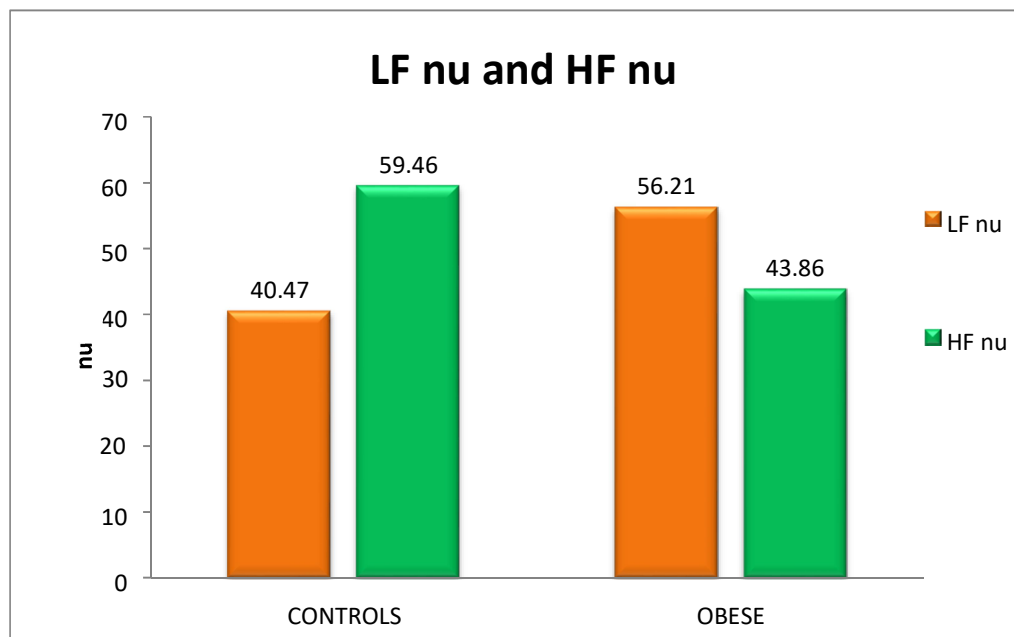
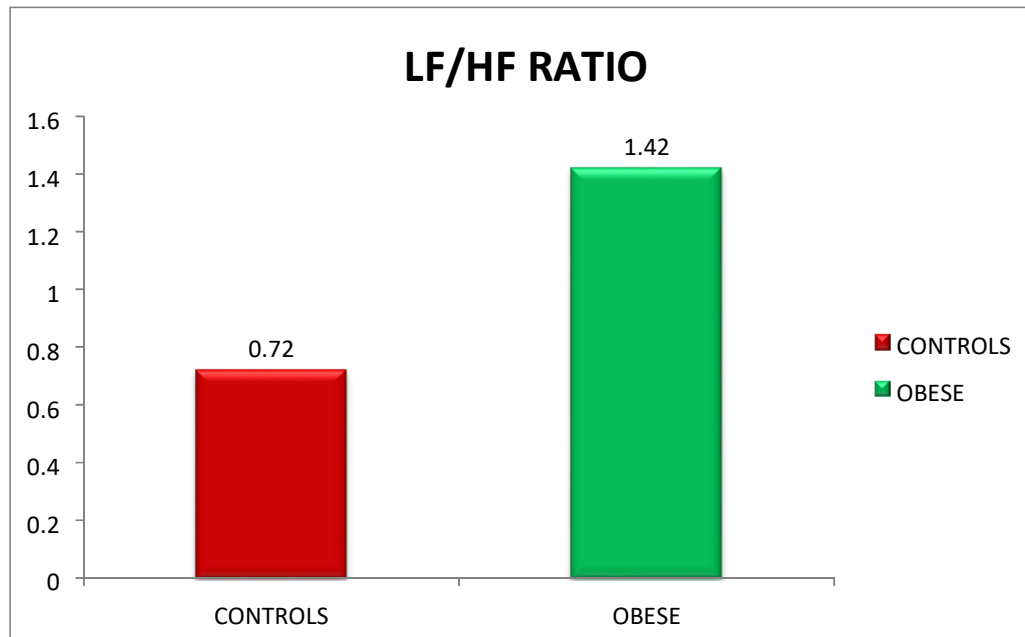


Figure 2 Comparison of LF/HF ratio between controls and cases



Discussion:

The present study was designed to assess the resting heart rate variability in young obese individuals. The study was aimed at including fifty young obese individuals of the age 18 to 25 years with BMI > 25 of both sexes and fifty age matched controls with normal BMI. There was a marked difference in the weight, BMI, WC, HC, WHR of the controls and the cases, which was very highly significant. Waist circumference and waist to hip ratio are direct indicators of abdominal obesity that is visceral fat. A greater waist to hip ratio and increased waist circumference were independently associated with a significantly increased risk of coronary heart disease (Yusuf S et al, 2004) ^[13] The study was accomplished using resting HRV. The integrity of sympathetic and parasympathetic components of the autonomic nervous system and the sympathovagal balance were assessed and there by substantiate the role of autonomic dysfunction in obesity and its comorbidities.

The cardiovascular autonomic functions are strongly influenced by sympathetic and parasympathetic divisions. The sympathetic nervous system has the control on the myocardial contractility and heart rate whereas the parasympathetic effect is essentially on the heart rate. There was a significant decrease of SDNN in the obese group. Similar results were shown by Emdin M et al, 2001^[14] and Archana et al, 2013^[15]. A reduction in SDNN, a parameter which reflects parasympathetic activity in this study implies a reduction in parasympathetic activity in obese. Though the mean HR in both the groups was within normal limits there is a significant increase in mean HR in the obese group which could be attributed to parasympathetic withdrawal in the obese. An increase in body weight is associated with an increase in mean heart rate due to decline in parasympathetic tone as stated by Hirsch J et al ^[16] in his study. Palatini et al ^[17] has stated in his study that higher heart rate could be a marker of relative

sympathetic dominance and is an independent marker of mortality in various conditions. This could be due to hemodynamic changes in obesity.

This study shows a highly significant variation in frequency domain variables. The LF and HF values are altered by the total power changes. To minimize this effect normalized values are taken. The Low Frequency in normalized units was increased more significantly in the obese group which indicates an increase in the sympathetic activity in the obese group. The HF nu shows significant decrease in the obese group which implies parasympathetic withdrawal as HF nu is an indicator of vagal activity. The LF/HF ratio which is an accurate measure of sympathovagal balance has increased in the obese group when compared to the control group which implies overall sympathovagal imbalance in the obese with sympathetic over activity and parasympathetic withdrawal. Mehmet Erkan Altuncu et al^[18], Karason k et al^[19] and Chen- chung fu et al^[20] in their studies have shown similar results. LF/HF ratio, the major indicator of sympathovagal balance shows a positive correlation with the body mass index and waist circumference in young obese group and hence an increase in body mass index and waist circumference as in obesity is associated with autonomic dysfunction. This study suggests that there is autonomic dysfunction in young obese individuals with parasympathetic withdrawal and sympathetic predominance with increased cardiovascular risks. Limitation of this study is that a prospective study with a follow up after weight reduction would be preferred. It would have been better if Catecholamine hormonal assay that is a direct measure of sympathetic system were also done.

Conclusion:

Resting HRV in young obese individuals indicate that there is a definite sympathovagal imbalance in the form of sympathetic over activity and parasympathetic withdrawal. Chronic activation of the sympathetic nervous system makes them more prone for adverse cardiovascular events at an early age. Early life style modification with changes in dietary pattern and increased physical activity could prevent further complications in this disease. HRV analysis can detect changes even before clinical signs appear and so be used as a biomarker for early detection and management of cardiovascular diseases in obese individuals.

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Was informed consent obtained from the subjects involved in the study? YES

For any images presented appropriate consent has been obtained from the subjects: NA

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