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A Comparative Study of Heart Rate Variability During Acute Mental Stress in Obese

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Abstract

Background: Under normal circumstances, reaction to mental stress would be increase in heart rate. Fluctuation in the time intervals in the successive heart beat is assessed by Heart rate variability (HRV). Analysis of heart rate variability during acute mental stress throws light on autonomic regulation. Since Obesity is morbid condition leading to cardiovascular disorder, we intend to study the heart rate variability during acute mental stress in obese individuals.

Method and results: This is a Case-control study conducted on 60 male adults (30 obese and 30 non obese) between 18 to24 years. All the subjects underwent mental arithmetic stress task for 5minutes. Then they were investigated for HRV parameters before mental stress task and during mental stress by recording ECG in lead II.

Results: In the time domain variables of HRV, mean heart rate showed a statistical significant increase ($p < 0.001$) in both obese and non obese individuals, while RMSSD and SDNN showed a statistical significant ($p< 0.001$) decrease in obese individuals and non obese individuals did not show statistical significant change during the mental stress task. During mental stress task there was decrease in all the components of frequency domain of HRV in obese with decrease in LFnu being statistically significant ($p= 0.002$). Whereas in non obese individuals, there was statistical increase in LF nu ($p < 0.001$) and LF/HF ratio ($p < 0.05$).

Conclusion: To conclude, this study indicates that the short-term mental stress led to changes in autonomic regulation both in obese and non obese group, but there was autonomic dysregulation in obese group in the form of decrease in parasympathetic activity.

Keywords: *Acute Mental Stress, Obesity, Heart rate variability.*

Introduction

Mental stress is a huge problem that affects many physiological parameters in our body causing imbalance in homeostatic mechanism [1]. No consensus about stress exists with respect to both definition and measurement. But our body responds to mental stress by increasing heart rate. We know that changes in heart rate are mainly depended on autonomic nervous system.

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Till date about different types of arithmetic manipulations of RR intervals have been used for

assessing autonomic activity [2]. Analysing Heart rate variability (HRV) represents one of the most promising such markers. It is the fluctuation in the time interval between consecutive heartbeats and provides powerful means of observing interplay between sympathetic and parasympathetic nervous systems[3].

From physiological point of view, a sympathetic dominance linked to increase in HRV may explain the relationship between stress and cardiovascular effects. Study by Shen B et al[4] indicate stress is an independent risk factor for acute myocardial infarction. The increased

risk may depend upon alteration in autonomic activity and reduction in vagal tone and HRV.

Obesity leads to whole spectrum of subsequent health problems. The major ones are cardiovascular, metabolic, orthopedic, gastroenterological, pulmonary and psychosocial

disorders. It has been proposed, and many experimental observations support the view, that the autonomic nervous system (ANS) plays an important role to maintain constant energy storage [5, 6]. It has been shown that disturbances in the pattern of stress related neuroendocrine and autonomic responsiveness is considered to be one of the risk factors of the development of hypertension and other cardiovascular diseases [7, 8]. Very few studies have been done on autonomic reactivity to mental stress in obese. Keeping this in mind, we intend to study the HRV parameters during acute mental stress in obese individuals and compare it with the normal weight individuals.

Materials and Method

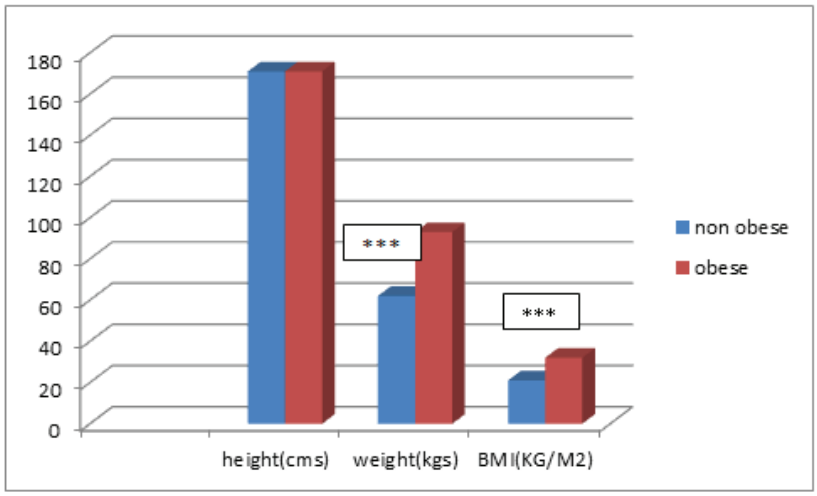
This case control study was conducted in the department of Physiology, JSSMC. Mysuru, after approval from institutional ethical committee. A sample size of 60, 30 each in study and control group were included for the study based on the mean and standard deviations of the study done by Garafova et al[9] with α error = 0.05 and β error of 0.20. Volunteer male students from medical college in the age group of 18-24 yrs were recruited for the study. The study group consisted of individuals of BMI > 30 Kg/m^2 and the control group of BMI < 25Kg/m^2.

After explaining the study protocol, informed written consent was obtained by all individuals in study and control group. The participants were advised to avoid food, beverages, exercise and smoking, 2hr prior to the commencement of the recording. After obtaining personal history, none of the subjects were previously diagnosed with cardiovascular disorder or does taking any medications that affect their heart rate. The resting blood pressure and ECG in lead II was recorded in all individuals after 10 minutes of rest. The ECG was recorded using AD instruments powerlab. Signal acquisition processing and storage was performed by the computer using HRV module software for lab chart pro 7. A stable, noise free, ectopic free fiducial points of R waves were located and time domain and frequency domain power spectrums of these R Waves were obtained from Fast Fourier Transformation using a sampling rate of 500Hz.

Then both obese and non obese individuals were subjected to Arithmetic stress task[10]. The task included subtracting 2 or 3 digit number from 4 digit number mentally and saying the answer aloud. Throughout the test, the subjects were instructed to work out quickly and gently chastised for wrong answers. During the stress task, the ECG in lead II was recorded and HRV parameters were obtained as described above. Arithmetic mean and standard deviation were worked out to obtain the values of the 2 group (obese and non obese group). Paired 't' test and independent sample 't' test was applied to assess the significance of changes within the group and between the group using SPSS version 20.

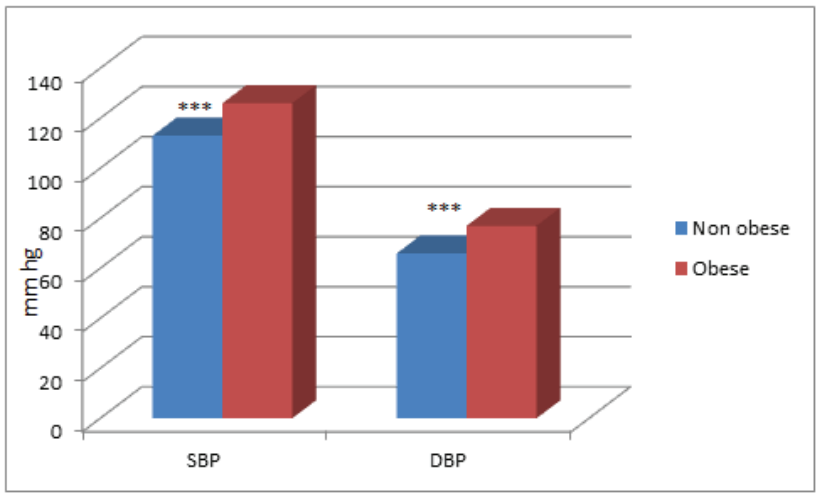
Results

Graph 1 depicts the anthropometric comparison between obese and non obese individuals



*** p value < 0.001 suggests very highly significant.

There was no significant difference in height between the 2 groups, but there was statistical significant difference in weight and BMI between the 2 groups.



*** p value < 0.001 suggests very highly significant.

Graph 2 depicts the comparison in systolic and diastolic blood pressure the 2 groups.

There was statistical significant increase in systolic and diastolic blood pressure in obese individuals when compared to non obese at rest.

Table 1 Showing comparison of time domain measures of HRV at rest and during acute mental stress in non obese subjects.

	At rest (Mean ± SD)	During mental stress (Mean ± SD)	p-value
Mean heart rate (bpm)	75±06	86±07	< 0.001***
SDNN (ms)	95±14	99±12	0.7
RMSSD (ms)	127±23	116±25	0.5

*** p value < 0.001 suggests very highly significant.

Mean heart rate was increased to mental stress in non obese adults but there was no change in SDNN and RMSSD in non obese adults to mental stress.

Table 2 Showing comparison of time domain measures of HRV at rest and during acute mental stress in obese individuals.

	At rest (Mean ± SD)	During mental stress (Mean ± SD)	p-value
Mean heart rate (bpm)	82±08	95±10	< 0.001***
SDNN (ms)	76±12	51±07	< 0.05*
RMSSD (ms)	82±10	50±05	< 0.05*

*** p< 0.001 suggests very highly significant.
*p< 0.05 suggests significant.

There was statistical significant increase in mean heart rate, decrease in SDNN and RMSSD in obese adults to mental stress.

Table 3 showing comparison of frequency domain measures of HRV at rest and acute mental stress in non obese individuals.

	At rest (Mean ± SD)	During mental stress (Mean ± SD)	p-value
LFnu	30±14	35±13	< 0.001***
HFnu	48±12	46±08	0.4
LF/HF	0.7±0.4	1.4±0.5	0.003**

*** p<0.001 suggests very highly significant
** p< 0.01 suggests highly significant

LFnu and LF/HF was significantly increased in non obese adults in response to acute mental stress.

Table 4 showing comparison of frequency domain measures of HRV at rest and acute mental stress in obese individuals.

	At rest (Mean ± SD)	During mental stress (Mean ± SD)	p-value
LFnu	49±14	38±18	0.002**
HFnu	37±07	34±10	0.2
LF/HF	1.4±0.5	1.2±0.7	0.12

**p< 0.01suggests highly significant.

There was decrease in LFnu and no significant change in HFnu and LF/HF ratio in obese adults to mental stress.

Discussion

The basal blood pressure was increased in obese individuals when compared to non obese individuals. This indicates that sympathetic nervonal activity is increased at rest in obese people. A large body of evidence clearly shows that sympathetic activity is increased in human obesity [11, 12]. So; at rest sympathetic nervous system is over activated in obese individuals.

In our study mean heart rate was increased in response to acute mental stress in both obese and non obese individuals. The difference in heart rate between resting condition and mental stress was expected as result of flight and fight response. But the time domain measures of HRV, that is SDNN and RMSSD was decreased in obese individuals in response to stress. SDNN (standard deviation of the NN interval) is mathematically equal to total power of spectral analysis and reflects all the cyclic components responsible for variability in the period of recording[13]. So a decrease in SDNN in obese individuals during acute mental stress indicates decrease in autonomic neuronal activity. The square root of the mean squared differences of successive NN intervals (RMSSD) is mediated predominantly by the parasympathetic influences on S A node [14].

Since RMSSD was decreased during acute mental stress, this indicated reduced parasympathetic activity. In a study by R. K. Mehta [15], similar findings were noted.

As expected there was significant increase in LF/HF ratio and LFnu in non obese individuals suggesting sympathetic system predominance during acute mental stress. These results are consistent with the data reported by Garafova[9] and Visnovcova [16].Wheras the frequency domain measures of HRV in obese individuals in response to acute mental stress showed a decrease in LFnu. As LFnu represents low frequency in the spectral band of HRV, it reflects the activities of both sympathetic and parasympathetic activity. As HFnu was also decreased, though not statically significant, we can say that there is parasympathetic withdrawal seen in obese individuals during acute mental stress that resulted in increase in mean heart rate in obese individuals during mental stress. This clearly indicates a reduced autonomic modulation to acute mental stress in obese individuals. Thus obesity causes differential activity of autonomic nervous system during mental stress as indicated in the review article by Maria Paulo et al [17].

To conclude, our study showed an increase in heart rate in response to acute mental arithmetic task in both obese and non obese individuals. The increase in heart rate in non obese individuals was mainly due to sympathetic activity but in case of obese individuals it was due to parasympathetic withdrawal which may result in many stress induced ailments in them.

Limitation of the study: Our study did not include gender moderation and did not include estimation of plasma epinephrine levels that could have added to the topic.

Conflict of Interest: NIL

Source of Funding: Self

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