

## Research article

**Effect of short-term mental stress on time- domain indices of heart rate variability in obese individuals – A case- control study**Priya S. A.<sup>1</sup>, Rajalakshmi R.<sup>2</sup><sup>1</sup>Assistant Professor, <sup>2</sup>Professor and Head, Department of Physiology, JSS Medical College affiliated to JSSAHER, S. S. Nagar, Bannimantap, Mysuru 570015, Karnataka, India

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Corresponding author: **Priya S. A.** Email: drpriyasa@gmail.com**ABSTRACT**

**Introduction and Aim:** Mental stress may impact dramatically on dynamic autonomic control on heart. Many studies have demonstrated association of high body mass index (BMI) with greater risk for cardiovascular disease with disturbance in autonomic neuronal activity. Analysis of Heart rate variability (HRV) during acute mental stress assesses the autonomic status of the individual. Hence, we aimed to study the effect of acute mental stress on time domain measures in obese adults.

**Materials and Methods:** Sixty male volunteers of 30 each in study group (obese individuals) and control group (non-obese individuals) were recruited for the study. A basal recording of ECG in lead II was done on all the individuals. Then they underwent mental arithmetic stress task for 5 minutes during which again ECG was recorded. The change in time domain measures of HRV during rest and stress task was analyzed and compared between both the groups.

**Results:** Analysis of time domain measures of HRV revealed a statistically significant increase ( $p < 0.001$ ) in mean heart rate in both obese and non-obese individuals, while rMSSD (root mean square differences of successive RR interval) and SDNN (standard deviation of all NN intervals) showed a statistically significant ( $p < 0.001$ ) decrease in obese individuals and non-obese individuals did not show any statistically significant change during the mental stress task.

**Conclusion:** In response to acute mental stress there was increased heart rate in both the groups. But the autonomic neuronal activity differed by way of sympathetic dominance in non-obese individuals and parasympathetic withdrawal in obese individuals.

**Keywords:** Heart rate variability; time domain indices; acute mental stress; parasympathetic withdrawal.

**INTRODUCTION**

Cardiovascular diseases have long been associated with risk factors such as obesity, diabetes, smoking, mental stress, excess blood cholesterol etc. Existence of more than one risk factors may accelerate the onset of cardiovascular disease and one of the consequences being sympathovagal imbalance (1). Many studies have shown that autonomic dysregulation can lead to the development of metabolic syndrome (2-5). Mental stress has shown to cause obesity related rise in blood pressure (6). Many studies have also shown that changes in neuroendocrine and autonomic reactivity to mental stress contributes to the development of cardiovascular diseases and hypertension (6, 7). Therefore, there can be mutual co- existence of mental stress and Obesity leading to autonomic dysregulation.

Mental stress can impact dramatically on dynamic autonomic control of the heart. There are numerous stress tests that causes changes in heart rate which can be detected in ECG recording and accordingly Heart rate variability analysis (HRV) can be done to know about sympathovagal balance. Analysis of HRV gives us valuable information about fluctuations in the time

interval between consecutive heartbeats and provides powerful means of observing interplay between sympathetic and parasympathetic nervous systems. Although Time domain measures of HRV is more promising in 24-hour ECG recording, some of the parameters of time domain such as MHR (mean heart rate), SDNN (standard deviation of all NN intervals) and rMSSD (root mean square differences of successive RR interval) can be analyzed to detect subtle changes in sympathovagal balance. So, the present study was taken up to assess the time domain indices of HRV changes to acute mental stress in obese individuals.

**MATERIALS AND METHODS**

Thirty obese male ( $BMI > 30 \text{ kg/m}^2$ ) volunteers aged 18-24 years were selected from University campus as a study subject and 30 non-obese male students ( $BMI < 25 \text{ kg/m}^2$ ) from the same campus formed the control group who were similar age. The criteria for obesity are based on WHO classification of obesity- International Obesity Task Force (IOTF) (8). Students practicing yoga, involved in daily sports activity, having cardiovascular illness, metabolic syndromes, consuming beverages and medications that can affect

the autonomic nervous system were excluded from the study. The study was conducted in the department of Physiology after obtaining clearance from the institutional ethics committee (JSS/MC/IEC/15/6074) prior to the commencement of the study, written consent was obtained from the study and control groups.

The subjects were asked to refrain from food and beverages 2hrs before the actual test was conducted. The study was conducted in a noise free room, with ambient room temperature and subject lying in supine position. After taking clinical history and anthropometric measurements, the subjects were asked to relax for 5 minutes, then a resting blood pressure and ECG in lead II was recorded in all individuals using AD instruments power lab data acquisition system with lab chart pro 7 for windows. Then both study group and control group were subjected to mental arithmetic stress task for 5 minutes during which, again ECG in lead II was recorded. The arithmetic stress task described by Holly (9) was included in the study. The mental arithmetic stress test is a verbally administered stress task. The subjects were instructed to rapidly subtract 1- or 2-digit numbers from 3- or 4-digit number in their mind and

asked to tell aloud the answer. This task depended on subject's skill level. So, throughout the task they were asked to work out quickly and gently chastised if they gave a wrong answer. This was done in order to increase the sympathetic response to perceived mental stress.

Then HRV analysis was done with sampling rate of 500Hz and through fast Fourier transformation. noise free and ectopic free, fiducial RR points are recognized and time domain measures of HRV like MHR,SDNN and rMSSD were computed.

The mean and standard deviation of time domain parameters so obtained was compared between the resting condition and mental stress task condition in both obese and non-obese individuals using SPSS version 20 with paired t test within individuals and independent sample t test between individuals.

## RESULTS

There was no significant difference between obese and non-obese in terms of age and height. However, there was significant difference in weight and body mass index (p-value <0.001) in the two groups (Table 1).

**Table I:** Comparison of physical parameters in non-obese and obese individuals.

Parameters	Non-obese (Mean $\pm$ SD)	Obese (Mean $\pm$ SD)	p-value
Age(years)	19 $\pm$ 0.7	19 $\pm$ 0.4	0.07
Height(cm)	171 $\pm$ 6	171 $\pm$ 4	0.7
Weight(kg)	62 $\pm$ 9	93 $\pm$ 7	<0.001***
BMI (kg/m <sup>2</sup> )	21 $\pm$ 2	32 $\pm$ 2	<0.001***

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

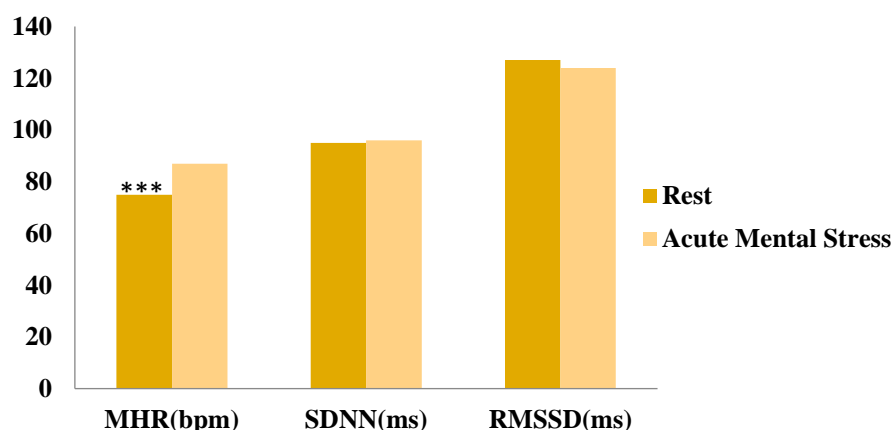
Table 2 shows systolic blood pressure and diastolic blood pressure at rest. There was a statistically significant increase in SBP (p<0.001) and DBP

(p<0.001) in obese individuals than non-obese subjects.

**Table 2:** Systolic blood pressure, and diastolic blood pressure at rest in non-obese and obese subjects.

Parameter	Non-obese (Mean $\pm$ SD)	Obese (Mean $\pm$ SD)	p-value
SBP (mm Hg)	113 $\pm$ 6	126 $\pm$ 8	<0.001***
DBP (mm Hg)	66 $\pm$ 4	77 $\pm$ 6	<0.001***

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

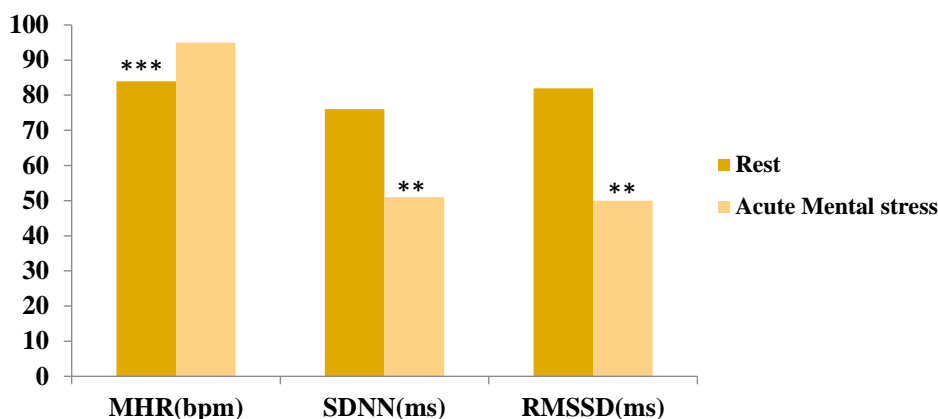


**Fig. 1:** Comparison of time domain measures of HRV at rest and during short term mental stress task in non-obese individuals.

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

Significant increase in mean heart rate to mental stress in non-obese adults was noted while, there was no

change in SDNN and rMSSD in non-obese adults to mental stress.



**Fig. 2:** Comparison of time domain measures of HRV between resting condition and during short term mental stress in obese individuals. \*\*\*  $p < 0.001$  suggests very highly significant. \*\*  $p$  Value  $< 0.001$  suggests highly significant

There was a statistically significant increase in mean heart rate, decrease in SDNN and rMSSD in obese adults to mental stress.

## DISCUSSION

In our study, the blood pressure at rest, both systolic and diastolic blood pressure was significantly high in obese individuals in comparison to non-obese individuals. This suggests that there may be sympathetic overdrive in obese individuals at rest. Adipokines are bioactive substances released from adipose tissue into blood stream. Of the various actions of adipokines, alteration in the sympathetic nervous activity by adjusting vascular muscle tone by balanced interplay between leptin and adiponectin attribute to sympathetic neuronal activity. The secretion of adipokines is altered due to infiltration of inflammatory cells in the white adipose in obese individuals, so there will be increase in leptin and proinflammatory cytokines and decrease in adiponectin contributing to obesity-related hypertension (10). Many studies have shown similar findings related to blood pressure in obesity (11, 12).

Consistent with few studies (13, 14), in our study also acute mental stress caused an increase in HR, SBP and DBP and this was seen in both the groups. This clearly shows that acute mental stress task caused a rise in sympathetic neuronal activity. In few studies, mental stress in the form of mental arithmetic task produced increase in muscle sympathetic nerve activity (13, 14) and LF (low frequency) component of the frequency domain of HRV (15), thus indicating shift of sympathovagal balance towards sympathetic dominance.

In one of the studies, they claim that parasympathetic withdrawal may be the cause for the increase in heart rate and blood pressure as pNN50 had reduced during stress condition, but the method of inducing mental stress was different from our study (16). Similar findings were observed in our study also. Acute mental

stress caused a decrease in SDNN and rMSSD in obese individuals. SDNN (standard deviation of the NN interval) indicates overall variability (17). So, a decrease in SDNN in obese individuals during acute mental stress indicates decrease in autonomic neuronal activity. The rMSSD is mediated predominantly by the parasympathetic influences on S A node (18). Since rMSSD was decreased during acute mental stress in obese individuals, this indicated reduced parasympathetic activity. In a study by Mehta (19), similar findings were noted. For better results, frequency domain measures of HRV are more reliable when ECG is recorded for short duration (20). Nevertheless SDNN, rMSSD, NN50 and pNN50 also are reliable, when ECG is recorded for short duration of time (5 min) (21) and analyzing time domain measures of HRV is easier when compared to frequency domain measure analyses. Heart rate variability parameters are better tools to measure the effect of mental stress task (22). Time domain measures of HRV shows subtle yet significant changes in autonomic regulation of heart rate to mental stress which could be used to diagnose subclinical risk factor for development of cardiovascular diseases.

## Limitations

Limitations of the study include subjective level of anxiety that contributes to autonomic regulation of heartbeat was not measured. In one of the studies subjective mental stress also showed changes in autonomic regulation of heart rate (23). Blood levels of epinephrine and gender moderation to autonomic activity to mental stress was also not measured. Only male participants were examined so our hypothesis may not hold good for general population or further work can be taken to see gender variation too.

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## CONFLICTS OF INTEREST

Authors declare no conflicts of interest.

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