RESEARCH ARTICLE

IMPACT OF OBESITY ON CARDIAC AUTONOMIC FUNCTIONS IN MIDDLE AGED MALES

Background: Obesity and health hazards associated with it are leading cause of death worldwide. The incidents of obesity are also rising at an alarming rate in the urban Indian population. Obesity is associated with adverse cardiovascular events which could be due to the altered autonomic balance seen in these individuals. Heart rate variability (HRV) is a non-invasive economical tool to assess the autonomic function.
Aims & Objective: The present study was undertaken to evaluate the effect of obesity on heart rate variability and to establish the relationship between BMI and HRV parameters.
Materials and Methods: Forty six males in the age group of 40-55 years, who satisfied the inclusion and exclusion criteria, were included in the study. The subjects were divided into two groups as obese and non-obese based on their BMI as per WHO guidelines for Asian subjects. The ECG was recorded for a period of 10 minutes and frequency domain parameters of HRV were derived from it. Parameters obtained were compared between both the groups using independent 't' test and relationship between BMI and HRV parameters was established using Pearson's correlation test. $P < 0.05$ was considered as significant.
Results: Obese individuals exhibited significantly lower values of both low and high frequency and normalized high frequency parameters. The ratio between low and high frequency and normalized low frequency parameters were significantly higher in obese group. A significant negative association was also observed between BMI and normalized high frequency parameter.
Conclusion: A reduced parasympathetic activity associated with elevated sympathetic was observed in middle aged obese males in the resting state. This is suggestive of a higher risk for development of cardiovascular disorders.
Key Words: Obesity; Parasympathetic Activity; Sympathovagal Balance

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INTRODUCTION

Obesity is defined as an excessive accumulation of fat in the body resulting in adverse effects on the health of the individual.[1] Following the global trend in the nutritional status, India also is shifting from undernourishment to obesity, especially in urban regions. Almost 30-65% of adult urban Indians are either overweight or obese with predominant abdominal obesity.[2] This rising trend of obesity is mainly attributed to high calorie diet and sedentary life style.[3] It is considered as one of the causative factors for multiple co-morbid conditions leading to metabolic and cardiac disorders.[4] This has generated interest among many researchers to study its effect on various organ systems in health and disease.

Obesity is the culmination of a chronic imbalance between energy intake and energy expenditure. The energy balance is to a reasonable extent affected by the status of autonomic nervous system (ANS) activity in the individual.[5] Heart rate variability (HRV) is a study of beat to beat variation in cardiac activity, which reflects the fluctuations in influence of sympathetic and parasympathetic divisions of ANS on the heart. Thus it is a simple, noninvasive tool to evaluate cardiac autonomic function.[6] Since study of HRV provides information about the influence of autonomic nervous function on the heart, it could be the most useful method by which the effect of obesity can be investigated on cardiovascular system.

Earlier studies have explored the association of obesity and cardiac autonomic function by using HRV in children[7] and young adults[8,9], literature review revealed significant lacunae in similar studies in older age groups. Analyses of HRV data support the observations that it is a predictor of sudden arrhythmic death, based largely on epidemiological follow-up studies.[10] Moreover, few studies have also suggested that the low HRV is also a predictor of non-arrhythmic cardiac events, such as myocardial infarction, rapid progression of atherosclerosis and death from heart failure.[11,12] With this background, the present study is an attempt to assess the resting cardiac autonomic activity in obese healthy middle aged Indian men.

MATERIALS AND METHODS

The study was conducted in the department of Physiology, MS Ramaiah medical college, as a cross sectional study.

The approval was obtained from Institutional scientific & ethics committee. Written informed consent was taken from each participant after explaining the detailed procedure and purpose of the study. A total of fifty male participants in the age group of 40-55 years, leading a sedentary life style were selected from the general population of Bangalore city for the study. A detailed history was also taken from all participants, later they underwent a thorough clinical examination. Based on history and clinical examination, individuals with previous history of heart failure, cardiac arrhythmias, valvular disease, congenital heart disease, myocardial infarction, pacemaker implantation, respiratory, endocrine and renal disorders, with a habit of consumption of alcohol, tobacco, on drugs modifying autonomic functions were excluded. On examination four individuals were found to be hypertensive were excluded from the study. Hence a total 46 individual were finally recruited for the study.

The participants reported to the laboratory in the morning. They were made to relax and be comfortable prior to the recordings. They were also instructed to abstain from consumption of stimulants and beverages like coffee or tea. Standing height was measured up till last 0.1cm without foot wear, with the subjects back to a wall and with both heels placed together and touching the base of the wall. Weight was recorded without foot wear, and with empty pockets to the nearest of 0.5 kg. BMI was calculated by using the formula weight in Kg / Height in meter^2 (Quetelet formula). Based on the Asian guidelines for obesity, subjects with BMI more than 25 kg/m^2 were considered as obese and those with values lesser than 25kg/m^2 were considered as non-obese.[13] After allowing them to take a rest for a minimum of 15 minutes in supine position, electrocardiogram (ECG) in Lead II was obtained for a continuous period of 10 minutes by placing the electrodes in right infraclavicular, left infraclavicular and left iliac regions. The ECG was analyzed in frequency domain for HRV by using RMS Vagus HRV software (RMS, India). The values for low frequency (LF) and high frequency (HF) were obtained in ms^2, the normalized units for LF and HF (LFnu, HFnu) were also noted along with the ratio of LF and HF (LF/HF). HF is mainly reflecting parasympathetic activity whereas LF/HF is an indicator of sympathovagal balance. All the techniques of measurement, duration, instruments were maintained uniformly throughout the study.

Statistical Analysis: All the data obtained in both obese and non-obese groups were expressed as mean ± Standard Deviation. The difference in parameters between the two groups was compared by using independent student 't' test. A relation between BMI and HRV parameters was determined using the Pearson correlation coefficient. $P < 0.05$ was considered as significant. SPSS software version 17 was used for the statistical analysis.

RESULTS

Forty six healthy middle aged males participated in this study. They were divided into two groups based on their BMI as per WHO Asian guidelines. Out of these, twenty six individuals with a BMI equal to or more than 25 kg/m^2 were considered as obese and the remaining twenty with a BMI less than 25 kg/m^2 were categorized as the non-obese group.

Table-1: Comparison of anthropometric data

	Obese (n=26)	Non-obese (n=20)	P value
Age (years)	50.54 ± 3.68	49.35 ± 4.53	0.33
Height (m)	1.58 ± 0.04	1.59 ± 0.06	0.50
Weight (kg)	67.42 ± 5.01	57.7 ± 4.91	<0.0001
BMI (kg/m^2)	27.18 ± 1.72	22.7 ± 1.38	<0.0001

Table-2: Heart Rate and HRV (frequency domain) parameters in both groups

Parameters	Obese (n=26)	Non-obese (n=20)	P value
HR (beats/min)	82.58 ± 8.26	81.55 ± 7.88	0.67
LF (ms^2)	34.58 ± 29.19	55.85 ± 39.14	0.04
HF (ms^2)	16.15 ± 16.27	30.55± 22.50	0.015
LFnu	68.92 ± 10.01	61.01 ± 11.62	0.017
HFnu	30.03 ± 7.34	39.89 ± 11.71	0.003
LF/HF	2.58 ± 0.88	1.76 ± 0.87	0.005

Table-3: Correlation showing the relation between BMI and HRV parameters

Parameters	LFnu	HFnu	LF/HF
R value	0.2	-0.336	0.242
P value	0.182	0.023	0.105

The age of the obese subject was 50.54 ± 3.68 year and of non-obese subject was 49.35 ± 4.53 year. There was no significant difference in the age. The difference in BMI between the two groups was found to be statistically significant ($p < 0.001$). The anthropometric parameters have been shown in table 1.

On comparison of frequency domain HRV parameters and heart rate between the two groups LF, HF and HFnu, was found to be significantly reduced and LFnu and LF/HF was found to be significantly higher in obese individuals (table 2).

On correlation of BMI with frequency domain parameters such as ratio of LF/HF, normalised units of LF and HF revealed a significantly negative relation with HFnu. A

positive relationship was also observed between LFnu and LF/HF ratio. However it was statistically not significant. (Table 3)

DISCUSSION

It is now a well-known fact that the beating of the healthy heart under resting condition is irregular. However, these beat to beat variations in the heart rate are easily overlooked when average heart rate is calculated. HRV is a non-invasive measure of heart rate fluctuations derived from ECG recording. Variation in R-R interval represents beat-to-beat control mechanisms of the heart. Sympathetic and parasympathetic activities directed to the sinus node during each cardiac cycle can be modulated by central and peripheral stimulators. Thus as a result of these stimulations, rhythmic fluctuations are generated in efferent neural discharge, which in turn manifest as oscillations in the heart beat period. HRV denotes the variability of both instantaneous HR and consecutive RR intervals. Hence cardiac autonomic function can be quantified by short term and long term HRV analysis.[6] So the present study was planned to use short term HRV analysis under resting condition in healthy obese middle aged males and to compare the same with non-obese individuals.

The factors like age, gender and physical activity can also influence the HRV other than obesity. However this study included only males leading a sedentary lifestyle within a same age group of 40-55 years (table 1). Thus both the groups in this study were matched for age, gender and physical activity, the only factors that differs between these two groups was obesity.

Even though the resting HR did not vary between both groups in this study, the HRV analysis revealed significantly lower values of LF, HF, and HFnu and higher values of LFnu and ratio of LF/HF in obese individuals. Similar results were also observed by Rajalakshmi et al. but their study was in younger population in the age group of 18-20 years. Fu CC et al. also observed similar findings in 12-13 year old Taiwanese children. Chetan HA et al have reported similar results in 20-24 year old young Indian males, but their criteria for obesity classification (BMI > 30 kg/m^2) was different. Compared to other ethnicities, it has been observed that Asians are more prone for obesity related disorders at lower levels of BMI. So in the present study effect of overall obesity was studied by considering BMI as an indicator, and the participants with BMI more than 25 kg/m^2 as obese as per WHO Asian guidelines.[6] LF/HF ratio, a widely used HRV index of sympathovagal balance between the two divisions of ANS. HFnu was considered as an index of modulation of parasympathetic branch of ANS as it influences sinoatrial node and LFnu was usually viewed as an index of modulation of the sympathetic division of the ANS.The representation of LF and HF in normalised units emphasizes the controlled and balanced behaviour of the two branches of the autonomic nervous system. Normalisation also tends to minimise the effect on the values of LF and HF components of the changes in total power. Hence the result of the present study reflects a reduced parasympathetic activity and altered sympathovagal balance in obese even in the resting state. The higher value of LF/HF ratio in obese can be interpreted as increased sympathetic activity. Previous studies have shown an elevated level of insulin and leptin in obese individuals. This increased level of insulin and leptin could be a reason for the increased sympathetic activity.

On correlation of BMI with ratio of LF/HF, normalised units of LF and HF revealed a significantly negative relation with HFnu. Rajalakshmi et al and Fu CC et al. have also observed a similar relation between BMI and HFnu in their studies. Further the study has also reported a negative relationship between HF and homeostasis model assessment of insulin resistance (HOMA-IR), which was considered to assess the insulin sensitivity. In the current study we have not assessed the insulin sensitivity, but the results of the study could be explained on the basis of increased insulin levels and or increased insulin resistance in obese individuals which leads altered sympathovagal balance in obese individuals.

CONCLUSION

In this study, it was observed that middle aged obese male individuals had reduced parasympathetic activity associated with elevated sympathovagal modulation. This altered balance of the autonomic nervous system increases the risk of cardiovascular disorders. Adopting healthy lifestyle practices such as regular exercise, yoga and also the dietary measures which reduce the weight can shift the sympathovagal balance towards vagal predominance which is known to be protective to the heart. Further studies in this field are necessary with a larger sample size including males and females of various age groups. Moreover the evaluation of metabolic status, insulin resistance and leptin levels could provide more information about influence of obesity on cardiovascular functions.

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