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Research Article

Heart Rate Variability in Overweight Individuals in supine and standing postures

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Abstract

Aim: To assess the autonomic function in overweight individuals, in supine and standing postures, using short term HRV test.
Methods: This study was conducted in40 normal weight individuals (BMI 20-23), and 40 overweight individuals (BMI 27-30), using short term HRV test.
Results: The changes in HRV values with change in posture were significantly reduced in overweight individuals. (ΔSDNN, $p<0.05$); (ΔRMSSD, $p<0.01$) ;(ΔNN50,$p<0.05$); (ΔpNN50,$p<0.05$); LF, $p<0.01$; HF , $p<0.05$;(Δ LF/HF, $p<0.01$) compared to healthy controls.
Conclusion: This study demonstrates that autonomic dysfunction may be present in asymptomatic over weight individuals. Earlier detection of autonomic dysfunction in overweight individuals could lead to medical intervention and lifestyle changes aimed at preventing obesity and its associated complications. However this study has a limitation in not accounting for visceral obesity in specific. More prospective studies are required to validate this inference.
Keywords: Heart Rate Variability (HRV), BMI (Body Mass Index), overweight, cardiovascular autonomic dysfunction.

1. Introduction

Almost two billion people in the world are reported to be overweight. They account for 38 percent of those over the age of 15 years. Over the last decade, overweight populations are spread across various regions and income groups. In 2002, 14 per cent of Indian adults were overweight; presently it has increased to19 per cent.[1]

Increased Weight gain, a by-product of rapid industrialization and sedentary lifestyle, has become a major health concern in the modern day society. Professor Martin Wiseman, of the World Cancer Research Fund, has stated that excessive body weight has long been linked to ill health and early death and is the second biggest risk factor for cancer after smoking. It is also associated with diseases such as type-2 diabetes and heart disease[2].

The cardiovascular autonomic neuropathy predisposes the subjects to greater chances of fatal and nonfatal myocardial infarction. With high prevalence rates of obesity, it becomes imperative that the autonomic function test is done at the earliest to detect, to retard and to prevent the deterioration of autonomic dysfunction. In the present study, we conducted the short term HRV test, which is one of the simplest tools to assess the CAN (cardiac autonomic neuropathy), in asymptomatic overweight individuals and their healthy controls.

2. Materials and Methods

2.1 Study design:

40 overweight males were enrolled in the study from the rural areas of Hoskote, Bangalore rural district. Similarly, 40 healthy male control subjects from the rural areas of Hoskote, Bangalore rural district, were included in the study. These study and control subjects were chosen based on the following Inclusion and Exclusion criteria.

2.2 Study Group

Inclusion Criteria:

1. Males with BMI 27 TO 30.
2. Age: 40 -45 years.
3. Resting heart rate: 60-80 beats per min.

Exclusion Criteria:

1. Hypertensives.
2. Diabetics
3. Smokers and / alcoholics.
4. Cardiac complications (arrhythmias , history of Myocardial Infarction)
5. Nephropathy (serum creatinine> 2mg/dl)
6. Endocrine disorders (thyroid, adrenal etc)
7. Those with injuries and painful conditi0ns such as arthritis.
8. Epileptics
9. Psychiatric disorders(depression, manic depressive illness etc)
10. Treatment with drugs like antidepressants, B blockers, antiarrhythmics, ACE inhibitors, thyroid stimulants, anti thyroid drugs.
11. Symptomatic diabetic autonomic neuropathy.
12. Trained athletes.

2.3 Control group

Inclusion Criteria

1. Males with BMI 20 TO 23.
2. Age: 40 -45 years.
3. Resting heart rate: 60-80 beats per min.

Exclusion Criteria:

1. Hypertensives.
2. Diabetics.
3. Smokers and / alcoholics.
4. Cardiac complications (arrhythmias , history of Myocardial Infarction)
5. Nephropathy (serum creatinine> 2mg/dl)
6. Endocrine disorders (thyroid, adrenal etc)
7. Those with injuries and painful conditi0ns such as arthritis.
8. Epileptics
9. Psychiatric disorders(depression, manic depressive illness etc)
10. Treatment with drugs like antidepressants, B blockers, antiarrhythmics, ACE inhibitors, thyroid stimulants, anti thyroid drugs.
11. Symptomatic diabetic autonomic neuropathy.
12. Trained athletes.

Ethical clearance for the study was obtained from the institutional ethical committee.

2.4. Methodology

The procedure of the HRV test was explained to the subjects in their own language and a well informed written consent was taken. The HRV of the subjects was assessed 2 hours after food and without any caffeinated drinks or strenuous exercise meanwhile. Anthropometric measurements such as height (m), weight (kg) were recorded. Resting blood pressure was measured using a mercury sphygmomanometer. Resting heart rate was recorded.

The resting ECG of 5 minutes was recorded in supine posture for all subjects, in lead II of ECG, in a state of physical and mental rest. The recording was done in a quiet, adequately illuminated and well ventilated lab. Then the subjects are asked to stand with support and further 5 minutes of ECG is recorded in the standing posture. Similarly, the ECG of 5 minutes in supine and 5 minutes in standing postures was recorded in the control subjects.HRV values were derived by the software.

The HRV equipment used was: RMS, VAGUS .MODEL: HRV. Serial no: HRV/121001/AOBX.

The following HRV parameters were recorded in each subject.

SDNN : Standard Deviation of the Normal to Normal beat R-R interval.
RMSSD : Root Mean Square of the Standard Deviations of the Normal to Normal beat R-R intervals.
NN50 : Successive Normal to Normal beat R-R intervals> 50 milliseconds.
pNN50 : Proportion of Normal to Normal beat R-R intervals> 50 milliseconds out of Total Normal to Normal beat R-R intervals.
VLF : Very Low Frequency (<0.04Hz)
LF : Low Frequency (0.04 – 0.1 Hz)
HF : High Frequency (0.15-0.4 Hz): Mainly depicts the parasympathetic component.

For each frequency band, measurements from the PSD Estimate consisted of both absolute and relative power of VLF, LF, and HF bands

LF and HF power bands were normalized

LF / HF : depicts the sympatho- vagal balance.

In short-term HRV recordings, Frequency domain methods are preferred to the time domain methods. The duration of recording should be at least for 10 times the lower frequency component wavelength. Thus, to assess the HF components of HRV, a recording of approximately 1 minute is required and approximately 2 minutes for assessing the LF component[3].

The VLF, LF, and HF power components are measured usually in absolute values of power (milliseconds squared). LF and HF can be measured in normalized units (n.u) as well. The relative value of each power component in proportion to the total power minus the VLF component can thus be represented. The effect of the changes in total power on the values of LF and HF components is minimized by normalisation. Measurements of LF and HF in normalized units (n.u) signify the sympatho-vagal balance[3].

2.5 Statistical Analysis

Student t Test was used for the statistical analysis of the results obtained. Software used statistical analysis was: Open Epi.

3. Results

Time Domain and Frequency Domain Parameter values are listed in Tables 1 and 2, respectively.

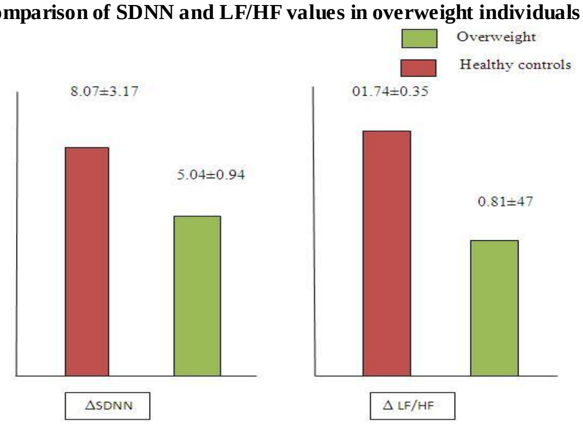
Table 1:Time Domain Parameters

	Overweight Supine (40)	Overweight standing (40)	Controls Supine(40)	Controls Standing(40)	Significance
SDNN	45.24±12	40.19± 11.04	58.82±21.24	50.75± 18.07	p<0.05
RMSSD	21.52± 18.61	19 .02± 21.37	32.29 ± 24.05	24.71±16.02	p<0.01
NN50	7.82 ± 1.04	5.3± 2.23	14.2± 3.77	10.3± 2.14	p<0.05
pNN50	11.81± 2.35	8.95± 2.1	17.28± 4.31	11.4± 3.02	p<0.05

Table 2: Frequency Domain Parameters

	Overweight Supine(40)	Overweight standing (40)	Controls Supine(40)	Controls Standing(40)	Significance
LF power (n.u)	78.45±16.39	80.41±29.04	61.82±19.29	76.18±17.57	p<0.01
HF power (n.u)	20.43± 2.55	18.28 ± 3.99	34.37± 13.88	22.94±7.51	p<0.01
LF/HF	3.91 ± 1.37	4.72± 2.25	1.74 ± 0.71	3.48± 1.06	p<0.01

Figure 1.Comparison of SDNN and LF/HF values in overweight individuals and healthy controls



5. Discussion

Heart rate variability is oscillation in the intervals between consecutive heart beats. Time domain" or "frequency domain methods of measuring the variation in HRV are used. These techniques are complementary to each other. Time domain measures are the standard deviation of normal R-R intervals (SDNN), the root mean square of successive R-R interval differences (RMSSD), and ,the number (NN50) and percentage of normal R-R intervals that differ by >50 ms (pNN50). These measures of HRV signify specific physiological autonomic regulatory activities. For example, the total power is denoted by SDNN but, both RMSSD and pNN50, which detect oscillations of high frequency, reflect the parasympathetic tone.

LF and HF can be measured in normalized units (n.u) as well. The relative value of each power component in proportion to the total power minus the VLF component can thus be represented. The effect of the changes in total power on the values of LF and HF components can be minimized by normalisation. Measurements of LF and HF in normalized units (n.u) reflect the sympatho-vagal balance. The HF component reflects the modulation of vagus nerve discharge during respiration. The LF and VLF components reflect the more gradual co-ordination between sympathetic and parasympathetic systems, influencing the variation in R-R interval.[3]

In this study, we have observed that the SDNN values in overweight individuals, signifying the total HRV, was significantly reduced ($p<0.01$) as compared to that of the controls. This can be attributed to the reduction in the indices signifying the parasympathetic tone such as the RMSSD, $p<0.01$); NN50 ($p<0.05$); pNN50 ($p<0.05$) and HF ($p<0.01$). The changes in HRV values with change in posture were significantly reduced in overweight individuals. We also found that overweight individuals had increased LF/HF ($p< 0.01$) signifying altered sympathovagal balance. This might also be due to increased sympathetic tone as reflected by increased LF ($p<0.05$). This results in a significant decrease in the ability to cope with the physiological challenge of standing.

Our study of the short term HRV of 5 min in diabetics is effective in demonstrating the possibility of cardiac autonomic dysfunction in asymptomatic overweight individuals as the other long term (24 hour holter monitor) studies.

Robert *et al* noted that duration of diabetes was significantly and inversely associated with HF power, RMSSD, which signify vagal-heart rate modulation and SDNN, representing total R-R variability among male subjects[4].

Seung-Hyun *et al* have shown that patients with an abnormal CAN as assessed by HRV Test consistently have an increased risk of cardiovascular mortality compared with those with normal assessment[5].

DCCT (Diabetes Control and Complications Trial) documented that intensive therapy can slow the progression autonomic dysfunctions[6].

However, it is reported that change in LF/HF in diabetics to upright position was similar to changes in cardiac autonomic control in subjects with CAD (Coronary Artery Disease). This suggests that there is a derangement in autonomic responses to changes in central stimuli in patients with CAD [7].

La Rovere *et al* have documented that in patients with CHF, a reduced LFP in short-term HRV test during controlled breathing is a strong predictor of sudden death and that it is independent of many other variables. These results help in specifically identifying those patients who are likely to benefit from prophylactic implantation of a cardiac defibrillator[8].

Results of the study by Tascılar *et al* indicate that there is parasympathetic withdrawal and sympathetic predominance in obese children. A marked decrease in HRV was observed in insulin-resistant obese children compared to their non-insulin-resistant obese controls. Thus, Tascılar *et al* opine that the autonomic imbalance pertaining especially to insulin resistance may be involved in the pathogenesis of obesity in paediatric patients[9].

Obese adolescents are found to have higher serum lipids, reduced insulin sensitivity and higher insulin resistance. They also present with progressive reduction of vagal indices (RMSSD, HF) and an increase in sympathetic indexes (LF, LF/HF), which correlated with beta-cell function parameters. Metabolic modifications may lead to an early impairment of the autonomic pattern[10].

Obesity is associated with reduced vagal nerve activity and elevated SBP with altered vagal and sympathetic nerve activity[11].

Zhao *et al* have studied the potential cardio-protective mechanisms of vagal nerve activation. Vagal activation results in cardio-protection associated with heart rate, anti-adrenergic effect, anti-inflammatory activity, regulation of cellular redox states and regulation of mitochondrial targets. They concluded that vagal nerve activation may be a promising new therapeutic approach for the treatment of cardiovascular diseases [12].

In pre hypertensives with higher BMI, it was seen that vagal withdrawal was more predominant than sympathetic over activity. Magnitude of alteration in LF-HF ratio corresponded to changes in BMI and DBP. BMI had an independent influence on LF-HF ratio[13].

Our study of the short term HRV of 5 minutes in the overweight is as effective in demonstrating the cardiac autonomic dysfunction in asymptomatic overweight as the other long term (24 hour holter monitor) studies. This results in a significant decrease in the ability to cope with the physiological challenge of standing. Similar results are obtained by a few other authors[14]. The overweight with cardiac autonomic dysfunction have higher incidence of fatal and non fatal myocardial infarction. Increased weight gain predisposes to development of hypertension, insulin resistance and diabetes and other cardiovascular problems associated with dyslipidemia[2].

Thomas *et al*[15] and Trombetta *et al*[16] in their respective studies have proved the improvements in HRV indices with weight loss in obese patients corresponding to better autonomic functions clinically.

CAN (cardiac autonomic neuropathy) remains subclinical and undetected during the early stages of obesity but accounts for high rates of morbidity and mortality in the later years. Thus short term HRV test could be used as a screening tool for early detection of cardiac autonomic dysfunction at the obesity clinics. Limitation of this study is that visceral obesity is not specifically accounted for, during the HRV test. Influence of ethnicity on BMI is to be assessed as well .Further studies to validate these inferences in large overweight populations are required.

6. Conclusion

1. Subclinical autonomic neuropathy is prevalent in overweight individuals as demonstrated by short term HRV tests.
2. Cardiac autonomic neuropathy in overweight individuals results in a significant decrease in the ability to cope with the physiological challenge of standing.

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