Original Article

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Physiology Section

# Heart Rate Variability in Overweight Health Care Students: Correlation with Visceral Fat

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## ABSTRACT

**Background and Objectives:** Increased sympathetic activity, decreased parasympathetic activity and sympathovagal imbalance (SVI) has been reported in obese individuals. However, the SVI and its association with visceral fat in overweight health care students have not been explored. Therefore, in the present study, we have assessed heart rate variability (HRV) and its association with visceral fat in overweight health care students.

**Materials and Methods:** Frequency domain parameters of HRV, body fat distribution and baseline anthropometric parameters were recorded in the control (n=40) and overweight (n=40) individuals. Further, the association of visceral fat with HRV was analysed.

**Results:** There was no significant difference in age and height of overweight group and control group (p = 0.732). The baseline heart rate and blood pressure (p<0.001) were higher in the overweight group. Total body fat, subcutaneous fat and visceral fat were higher in the overweight group (p<0.001). Among frequency domain parameter of HRV, LFnu and LF: HF were more in the overweight group (p<0.001). Further, HFnu was less in the overweight group (p<0.001).

**Conclusion:** Sympathovagal imbalance due to increased sympathetic activity and its association with visceral fat was observed in overweight individuals.

**Keywords:** Obesity, Sympathovagal imbalance, Vagal tone

## INTRODUCTION

Overweight and obesity are due to abnormal or excessive fat accumulation that may impair health and it is because of an imbalance between calories consumed and expended. The global epidemic of overweight and obesity is the major public health problem in developed as well as developing world. Obesity has reached epidemic proportions in India in the 21st century with morbid obesity affecting 5% of the country's population [1]. According to National Family Health Survey data, 12.1% males and 16% females of the Indian population are obese/overweight, and Andhra Pradesh with 17.6 % males, 22.7 % females [2]. Abdominal obesity, defined as increased waist circumference is one of the components of the constellation of metabolic abnormalities collectively called as the metabolic syndrome (MS). The latest definition of MS by the International Diabetes Federation (IDF) has included abdominal obesity as one of the essential components [3].

Among the different available non-invasive techniques for assessing the autonomic status, Heart Rate Variability (HRV) is a simple method to evaluate the Sympathovagal balance at the sinoatrial level [4]. Increased sympathetic activity, decreased parasympathetic activity and sympathetic imbalance (SVI) has been reported in obese individuals [5-7]. However, the SVI and its association with visceral fat in overweight health care students have not been explored. Therefore, in the present study, we have assessed HRV and its association with visceral fat in overweight health care students.

## MATERIALS AND METHODS

This is a cross-sectional study carried out in the Department of Physiology, Narayana Medical College (NMC), Nellore, Andhra Pradesh, India, from May to October 2014, the study was approved by Institute ethics committee.

**Sample size calculation:** Sample size was calculated using nMaster 2.0 (BRTC, Department of Biostatistics, CMC, Vellore) with expected correlation between visceral fat and increased sympathetic activity will be 0.5. In order to show that this is significantly different from 0 at alpha error 5% and power 80%, with 2 sided test, we need to study 40 subjects in each group.

**Recruitment of participants:** After getting written informed consent, participants were recruited from medical, dental and paramedical students of NMC, based on the body mass index (BMI) classification for Asian population [8], They were divided into two groups. Those in the age group of <18 y and >30 y, doing regular exercise/yoga, with the history of hypertension, cardio-pulmonary disease, taking drugs which affect autonomic function, habit of smoking, tobacco, alcohol intake and drug abusers were excluded from the study. Clinical examination was conducted on all subjects to rule out any systemic disorders. Thus 80 students were available for the study satisfying the inclusion and exclusion criteria. Over weight group (n=40): Healthy individuals having BMI 23.00 – 27.40, Control group (n=40): 18.50 – 22.90.

**Recording of anthropometric parameters:** Weight to the nearest 0.5 Kg by digital weighing scale, height to nearest millimeter by stadiometer was measured. Height, Waist circumference (WC) and Hip Circumference (HC) to the nearest 0.1 cm were measured for each student according to standard procedures. Body Mass Index (BMI), Waist Hip Ratio (WHR) was then calculated. BMI was calculated by dividing weight in Kg by the square of the height in meters and the WHR was calculated by performing appropriate divisions.

**Laboratory conditions and recording of heart rate (HR), blood pressure (BP) and HRV:** All recordings were carried out in the cardiac autonomic function research laboratory. HRV was recorded at 8.00 AM following ten minutes of rest in supine position. The volunteers were instructed to not participate in physical exercise for 24 h intake of alcohol and caffeinated beverages for 12 h before recording. The laboratory temperature was maintained at 25°C - 28°C and lights subdued. The volunteers were asked to sit in the laboratory comfortably to adjust with lab conditions. First, HR and BP were recorded after the volunteer had been sitting for ten minutes. The average of three recordings with a maximum variation of 4 mm Hg of both systolic and diastolic BP was accepted [9]. Then lead II ECG was recorded at the rate of 200 samples/sec for 10 min with the normal breath rate of 12-18/min using an ECG machine (Cardiowin system, PC based 12 channel simultaneous digital ECG, Genesis Media System Pvt. Ltd, India). The Task Force recommendations on HRV [4] were followed; an RR interval series was selected from ECG. Frequency domain indices such as total power (TP), normalized LF power (LFnu), normalized HF power (HFnu) and LF-HF ratio were calculated.

**Measurement of body fat distribution:** Body fat distribution was measured by using body fat analyser (Omron HBF 375) working under the principle of bioelectrical impedance analysis (BIA) method.

## STATISTICAL ANALYSIS

Statistical Package for Social Sciences Version 16.0. was used for statistical analysis. Data were expressed as mean ± Standard Deviation. Normality was tested by Kolmogrov Smirnov test. Two tailed unpaired t-test was used to see the level of significance between groups. Association between visceral fat and HRV was tested by using Pearson's correlation coefficient. The null hypothesis was rejected at p<0.05.

## RESULTS

There was no significant difference in age and height of overweight group and control group (p=0.732). Weight, BMI and WHR (p<0.001) were significantly high in overweight group. The baseline HR, SBP, DBP (p<0.001) were higher in overweight group [Table/Fig-1].

As shown in [Table/Fig-2], TBF%, SCF% and VF% were high in overweight group (p<0.001). Among frequency domain parameter of HRV, LFnu and LF:HF were more in overweight group (p<0.001). Further, TP and HFnu were less in overweight group (p<0.001) [Table/Fig-3].

Further, the association of visceral fat with HFnu was negative (r = -0.32) and positive with LFnu (r = 0.40) and LF: HF (r = 0.35) in overweight group [Table/Fig-4].

| S.No | Parameter | Visceral fat % | |
|---|---|---|---|
| | | Overweight group | |
| | | r-value | p-value |
| 1 | LFnu | 0.40 | <0.001 |
| 2 | HFnu | -0.32 | <0.001 |
| 3 | LF:HF | 0.35 | <0.001 |

**[Table/Fig-4]:** Frequency domain parameters of HRV and its association with visceral fat in overweight group
LF: Low frequency component, HF: High frequency component, LFnu: Normalized low frequency component, HFnu: Normalized high frequency component

## DISCUSSION

Over the past decade, overweight populations are distributed across different locations and income groups. Fourteen percent of Indian adults were reports as overweight in 2002, currently it has been amplified to 19% [10].

During normal sinus rhythm, the HR varies from beat to beat. HRV results from the interplay between the various physiological mechanisms that regulate the heart rate. Since short term heart rate regulation is predominantly governed by sympathetic and parasympathetic neural activity, by examination of heart rate fluctuations normal functioning of the autonomic nervous system can be tested [11].

Our findings corroborate with previous report [12]. They demonstrated the autonomic dysfunction in asymptomatic overweight individuals. However, they didn't follow Asian BMI criteria and association of visceral fat with HRV. This study is unique that, we followed Asian BMI criteria and association of visceral fat with HRV.

The present study showed that the HR and BP was significantly higher in overweight group. Higher heart rate is a marker of relative sympathetic dominance and is an independent marker of mortality in a wide spectrum of conditions [13]. This study also showed the significantly lower TP, HFnu and high LFnu and LF-HF ratio in overweight subjects [Table/Fig-3]. High LFnu reflects the sympathetic drive to the heart [14], LF-HF ratio is a sensitive marker of SVI [15], HFnu and TP represents the vagal activity of heart [14,16].

| S. No | Parameter | Control group (n=40) | Overweight group (n=40) | p-value |
|---|---|---|---|---|
| 1 | Age (years) | 26.58 ± 8.24 | 27.32 ± 6.62 | 0.732 |
| 2 | Height (cms) | 164.68 ± 26.53 | 165.71 ± 29.54 | 0.856 |
| 3 | Weight (kg) | 59.25 ± 13.45 | 69.57 ± 17.34 | <0.001 |
| 4 | BMI (Kg/m$^2$) | 21.80 ± 9.45 | 25.30 ± 11.43 | <0.001 |
| 5 | WHR | 0.78 ± 0.23 | 0.91 ± 0.31 | <0.001 |
| 6 | HR (bpm) | 68.43 ± 8.42 | 79.24 ± 8.4 | <0.001 |
| 7 | SBP (mmhg) | 108.34 ± 23.47 | 127.53 ± 21.45 | <0.001 |
| 8 | DBP (mmhg) | 71.89 ± 15.34 | 85.43 ± 26.34 | <0.001 |

**[Table/Fig-1]:** Baseline characteristics of control and overweight subjects
Values are expressed as mean ± SD; BMI: Body mass index, WHR: Waist hip ratio, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

| S. No | Parameter | Control group (n=40) | Overweight group (n=40) | p-value |
|---|---|---|---|---|
| 1 | TBF % | 18.34 ± 5.56 | 27.77 ± 3.80 | <0.001 |
| 2 | SCF % | 11.45 ± 4.34 | 20.33 ± 5.19 | <0.001 |
| 3 | VF % | 4.56 ± 2.45 | 11.13 ± 4.13 | <0.001 |

**[Table/Fig-2]:** Body fat distribution of control and overweight subjects
Values are expressed as mean ± SD; TBF: Total body fat, SCF: Subcutaneous fat, VF: Visceral fat

| Sl. No | Parameter | Control group (n=40) | Overweight group (n=40) | p-value |
|---|---|---|---|---|
| 1 | LFnu | 47.2 ± 12.54 | 68.18 ± 11.16 | <0.001 |
| 2 | HFnu | 52.8 ± 12.54 | 31.82 ± 11.16 | <0.001 |
| 3 | LF:HF | 0.895 ± 225.56 | 2.71 ± 1.80 | <0.001 |
| 4 | TP (ms$^2$) | 932.67 ± 435.45 | 596.50 ± 276.63 | <0.001 |

**[Table/Fig-3]:** Frequency domain parameters of HRV in control and overweight groups
Values are expressed as mean±SD; TP: Total power, LF: Low frequency component, HF: High frequency component, LFnu: Normalized low frequency component, HFnu: Normalized high frequency component

Findings of this study of increased sympathetic activity in the form of increased LFnu and decreased parasympathetic activity in the form of decreased HFnu depicts the nature of alteration in the SVI as the mechanism for risk of cardiovascular diseases (CVD) in overweight individuals.

Further, correlation analysis between the body fat distribution and HRV indices in this study showed that the LFnu and LF-HF ratio of HRV were significantly correlated positively and HFnu was negatively correlated with visceral fat percentage. It indicates the link between visceral fat and SVI.

The precise mechanism that leads to deterioration of cardiovagal function was not established clearly. Obesity is a state of reduced glucose threshold, insulin resistance and hyperinsulinemia. Acute insulin administration showed reduction in HFnu, an indicator of respiratory sinus arrhythmia [17,18]. Thus, low cardiac activity may be due to hyperinsulinemia [19].

## LIMITATIONS AND FUTURE PERSPECTIVES

There are some limitations to our study. Being a cross-sectional study, no cause/effect inferences can be drawn. Secondly, we have not used the gold-standard measurement of visceral fat as it is very expensive. Finally, As HRV is not an adequate measure to assess the sympathetic activity; further studies may use more precise methods like estimation of metabolites of catecholamines in urine and plasma catecholamine estimations.

## CONCLUSION

From this study, it is concluded that, overweight individuals may suffer from an increased mortality risk due to CVD related to either continuously lowered parasympathetic or altered sympathetic activation. Early detection and management by weight reduction and regular exercise/yoga may reduce these risks. Thus regular assessment of HRV measures can be used as a biomarker for early detection and subsequent management of CVD in overweight individuals.

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