Research Article

Assessment of cardiac sympathovagal activity in overweight young adult males

Latha Ramalingam[1], Rajalakshmi Ramesh[2], Ratchagan Kuppan[1]

[1]Department of Physiology, Shri Sathya Sai Medical College and Research Institute, Sri Balaji Vidyapeeth University, Kancheepuram, Tamil Nadu, India.
[2]Department of Physiology, Indira Gandhi Medical College and Research Institute, Puducherry, India.

Correspondence to: Latha Ramalingam, E-mail: lathura@gmail.com

Received November 1, 2015. Accepted November 12, 2015

Abstract

Background: When a person's body mass index (BMI) is above the normal range but below the threshold for obesity, he or she is termed as overweight (BMI = 25–29.9 kg/m^2). Recently, the incidence of myocardial infarction has greatly increased among the young adults. This is mainly due to stress, sedentary lifestyle, and increased intake of junk foods. Reduced heart rate variability (HRV) is a sign of poor cardiac autonomic function. Obese individuals are known to have reduced HRV. However, there are not many studies that have explored the changes in HRV indices among the overweight individuals. **Aims and Objective:** To find out the influence of higher BMI on HRV in overweight young adult men. **Materials and Methods:** Eighteen men (30 ± 4 years, mean ± SD) with BMI in the overweight range (test group) and 18 age-matched men with normal BMI (control group) were included in the study. Five-minute ECG was recorded in lead II configuration in all the subjects following 10 min of rest in supine posture. HRV parameters (time domain and frequency domain) were derived from the ECG. The HRV parameters of the test and the control group were compared using Mann–Whitney *U*-test. A *p*-value of <0.05 was considered significant. **Result:** Overweight individuals had a significantly high mean heart rate ($p = 0.029$) and a significantly low RMSSD (root mean square of successive differences) ($p = 0.035$) and high-frequency (HF) normalized units (nu) values ($p = 0.049$) indicative of decreased parasympathetic activity. Low-frequency (LF) nu ($p = 0.069$) and LF/HF ratio ($p = 0.082$) values were higher in the test group, but not significant. SDNN (standard deviation of the NN intervals), a measure of total HRV, was also significantly low in the test group ($p = 0.019$). **Conclusion:** Apparently healthy overweight men have reduced HRV, which may lead to increased cardiovascular morbidity and mortality in these individuals. Hence, emphasis must be placed on early adoption of lifestyle modifications to prevent the progress of impending alterations in cardiovascular status of these young adults.

KEY WORDS: Overweight Young Males; Heart Rate Variability; Autonomic Functions; Time Domain Analysis; Frequency Domain Analysis

Introduction

Worldwide the incidence of overweight and obesity is increasing at a faster rate. The imbalance between energy consumption and energy expenditure causes overweight and obesity. People who are overweight today will become obese if they are not aware of the consequences of inappropriate weight gain. According to the World Health Organization (WHO), increased body mass index (BMI) is a major risk factor for most of the noncommunicable diseases such as diabetes; cardiovascular diseases; musculoskeletal disorders such as osteoarthritis; and carcinoma of colon, breast, and endometrium.[1] An expert WHO consultation conducted in Asian population reported that the risk of diabetes and cardiovascular diseases occur in people whose BMI is lower than that of the cutoff value for overweight given by the WHO.[2]

Obesity, a major risk factor for many health-related disorders, is known to be associated with decreased cardiac autonomic

Access this article online	
Website: http://www.njppp.com	Quick Response Code:
DOI: 10.5455/njppp.2015.5.0111201589	

functions. Heart rate variability (HRV), a measure of the beat-to-beat variation in the RR intervals, is a simple and noninvasive method that helps to assess the cardiac autonomic status of the individuals. Obese individuals are known to have reduced HRV due to increased sympathetic activity and decreased parasympathetic activity.[3] There was sympathetic overactivity in obese men when compared with normal men.[4] HRV indices such as RMSSD (root mean square of successive differences) and low-frequency (LF) values were negatively correlated with body fat mass and fat percentage.[5] Although there is adequate data regarding the effect of obesity on HRV, knowledge regarding the changes in HRV among overweight individuals is very limited. Hence, in this study, the HRV indices were assessed in young adult men with BMI in the overweight range and compared with those of age-matched men with normal BMI.

Materials and Methods

Thirty-six healthy male volunteers in the age group of 20–40 years were included in the study. Height of the subjects was measured using a stadiometer and their weight using a weighing scale. BMI was calculated using Quetelet index. Individuals with BMI in the range of 25–29.9 kg/m^2 were classified as overweight and taken into test group and those with BMI in the range of 18–24.9 kg/m^2 were classified as normal and taken into control group. The study was prior reviewed and approved by the institutional ethical committee. Written informed consent was obtained from all the study participants before recruiting them in the study. However, chronic smokers, alcoholics, and those with history of cardiovascular disorders, diabetes, and hypertension were not included in the study.

Recording of Blood Pressure

Blood pressure was recorded in all the subjects after 10 min of rest in sitting posture using a manual sphygmomanometer.

Recording of Heart Rate Variability

HRV was recorded in all the subjects in the morning hours between 9 and 11 am, 2–3 h after a light breakfast. The study subjects were asked to refrain from smoking and drinking caffeine containing beverages or alcohol for 12 h prior to the recording. The subjects were asked to rest in supine position for 20 min following which 5-min ECG was acquired in lead II configuration. Following standardized procedures,[7] the RR intervals were derived from the ECG data and fed to the Kubios HRV analysis software, version 2, to obtain the time domain and frequency domain indices of HRV. Time domain parameters, such as RMSSD, pNN50, mean RR intervals, and SDNN, give us the information about the autonomic activity in the person whereas power spectral analysis of the RR tachogram using fast Fourier transformation gives the LF, high-frequency (HF), and very low frequency (VLF) values, which gives information on the autonomic balance, that is, dominant sympathetic or parasympathetic tone in the subject.

Statistical Analysis

Statistical analysis was done using SPSS software, version 20. The values are expressed as mean and standard deviation. Graphical analysis for representational purpose was done with Igor Pro software, version 6. Mann–Whitney *U*-test was performed to compare the study variables of the test and control groups. A *p*-value of $\leqslant 0.05$ was considered to be significant.

Result

The mean age, BMI, and blood pressure measurements of the subjects in the test group and the control group are given in Table 1. The mean age of men in the test group and the control group is similar so that the variations in HRV are not due to difference in the ages. The mean BMI is significantly different in between the groups, which is the essential criteria for this study. Systolic blood pressure (SBP) is significantly higher in the overweight men with *p*-value of 0.010, though the absolute values of the mean SBP does not fall in the range of hypertension. But the diastolic blood pressure (DBP) and mean arterial pressure values were similar in the test and the control groups.

Time Domain Analysis

The mean and standard deviation values of the parameters under time domain analysis are given in Table 2. There is a significant difference in all the time domain parameters, which implies a decreased parasympathetic activity in the overweight men. Mean RR intervals are significantly lower in the test group, with higher values of the mean heart rate in most of the overweight men compared to the control group (Graph 1).

Table 1: Comparison of anthropometric variables and blood pressure values between the control and test groups

Parameters	Control (normal BMI), *N* = 18 Mean (SD)	Test group (overweight), *N* = 18 Mean (SD)	*p*-value
Age (years)	26.52 (5.70)	26.72 (6.19)	0.368
BMI (kg/m^2)	21.86 (1.56)	26.98 (1.66)	<0.001*
SBP (mm Hg)	116.88 (8.2)	124.11 (7.8)	0.010*
DBP (mm Hg)	74.58 (6.51)	75.66 (7.94)	0.664
MAP (mm Hg)	88.82 (5.96)	91.81 (6.7)	0.173

*$p < 0.05$ is considered significant.

Table 2: Comparison of time domain indices between normal weight and overweight individuals

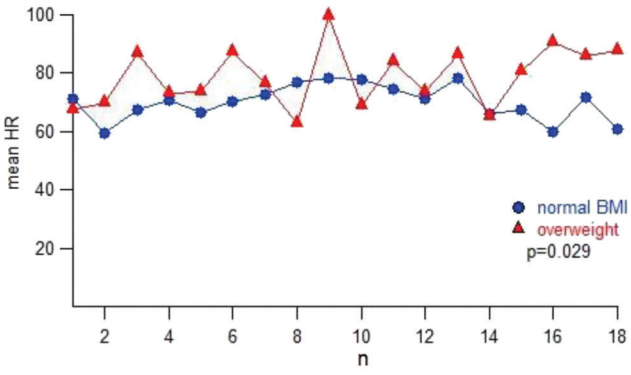
Parameters	Control group (normal BMI), *N*=18 Mean (SD)	Test group (overweight), *N*=18 Mean (SD)	*p*-value
Mean RR (ms)	793.06 (100.93)	858 (72.27)	0.043*
Mean HR (1/min)	77.91 (10.03)	71.34 (5.16)	0.029*
SDNN (ms)	33.8 (11.91)	44.52 (12.48)	0.019*
RMSSD (ms)	28.78 (13.96)	40.3 (15.47)	0.035*
pNN50 (%)	9.40 (11.34)	18.90 (13.57)	0.048*

*$p < 0.05$ is considered significant.

The individual mean values of the standard deviation of the NN intervals (SDNN) of the subjects in the test group are lower compared to the control group (Graph 2) and the difference is statistically significant. RMSSD (square root of the mean squared differences of successive NN intervals) estimates the HF variations in the heart rate in short-term recordings. Graph 3A represents the mean RMSSD values that are significantly lower (p = 0.035) in the overweight men than those in the control group. Overweight young men have significantly lower pNN50% (standard deviation of RR intervals that differ more than 50 ms) compared to the men with normal BMI as shown in Graph 3B.

Frequency Domain Analysis

Table 3 gives the frequency spectral analysis of the ECG tachogram of the test group and the control group subjects. The parameters reflect an autonomic imbalance in the overweight men. Total power includes the summation of VLF, HF, and LF power. VLF power is valuable if the analysis is done for long-term ECG recording (24 h HRV) analysis. The HF power is higher in the control group than in the test group and it is significant. HF power nu (normalized units) is also significantly higher in men with normal BMI and LF power nu is higher in the overweight men, though it is not statistically significant as shown in Graph 4A. Graph 4B represents the higher value of LF/HF ratio in the test group, but it is not statistically significant.

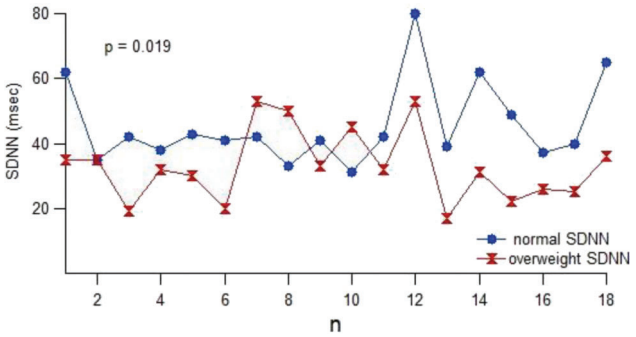


Graph 1: Mean heart rate in test and control groups. Most of the values of RR intervals are lesser in the overweight men, which is suggestive of a higher heart rate in them compared to the control group (p-value by Mann–Whitney U-test = 0.029)

Discussion

HRV analysis is emerging as an important investigation tool to assess the cardiac autonomic status of the individuals in various clinical conditions especially with regard to noncommunicable diseases.[8] Reduced HRV clusters with other cardiovascular risk factors such as higher triglycerides and coronary artery calcification in young adults.[9] Studies on obesity and HRV[10,11] in young adults have shown that obese individuals have increased cardiac sympathetic activity, decreased parasympathetic activity, and reduced total HRV. In this study, we have tried to explore if the changes in HRV manifested in obese individuals are also present in overweight men.

In this study, it was observed that the overweight men had significant changes in short-term HRV parameters when compared with their age-matched controls with normal BMI. Comparison of SBP and DBP of the test and the control group revealed a significantly high SBP among the test group individuals whereas there was no difference between the groups with respect to DBP. This finding is consistent with the study by Babu et al.,[12] which has also reported a significant positive correlation of SBP with BMI. The significantly reduced RR intervals among the test group individuals indicate an increased cardiac sympathetic tone in these individuals. However, frequency domain indices indicative of

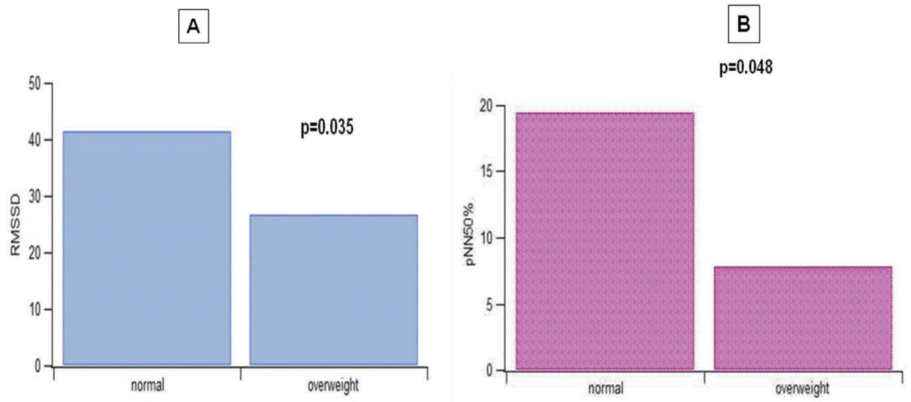


Graph 2: SDNN values are significantly lower in the overweight men (p-value by Mann–Whitney U-test = 0.019)

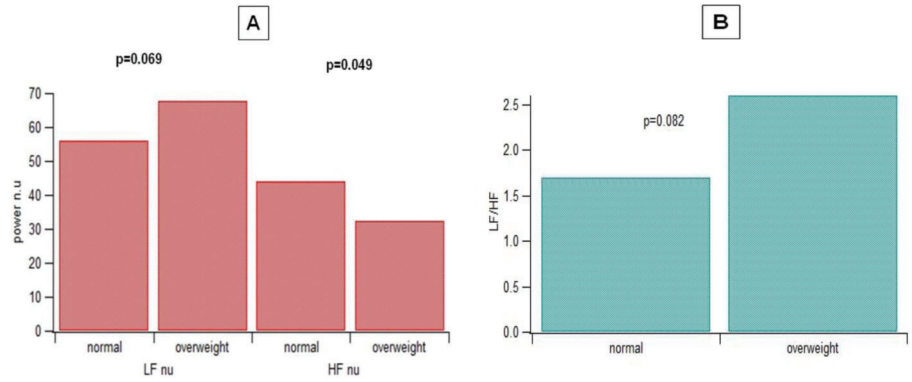
Table 3: Comparison of frequency domain indices between normal weight and overweight individuals

Parameters	Control group (normal BMI), *N*=18 Mean (SD)	Test group (overweight), *N*=18 Mean (SD)	*p*-value
LF power (ms^2)	310.83 (183.90)	197.11 (160.71)	0.056
HF power (ms^2)	258.93 (115.5)	209.07 (103.77)	0.027*
Total power (ms^2)	704.83 (439.69)	393.94 (288.94)	0.017*
LF (nu)	55.38 (16.29)	65.47 (12.40)	0.069
HF (nu)	44.61 (16.29)	33.99 (12.13)	0.049*
LF/HF ratio	1.693 (1.358)	2.605 (1.680)	0.082

*$p < 0.05$ is considered significant.



Graph 3: (A) RMSSD values are also significantly lower in the overweight individuals (*p*-value by Mann–Whitney *U*-test = 0.035). (B) pNN50 is also reduced in test group (*p*-value by Mann–Whitney *U*-test = 0.048). All these are suggestive of significant decrease in parasympathetic activity in overweight adult men



Graph 4: A) LF nu is higher in overweight men though not statistically significant and HF nu is lesser and also statistically significant (*p*-value by Mann–Whitney *U*-test = 0.049), indicating autonomic imbalance in overweight young adult men. (B) Similarly, LF/HF ratio is higher in the test group indicating sympathetic dominance in this group

sympathetic activity such as LF power, LF nu, and LF/HF (sympathovagal balance) were not significantly different between the two groups. This is inconsistent with the findings of Chintala et al.[13] who have demonstrated the predominance of sympathetic activity in overweight young individuals.

HRV parameters indicative of cardiac parasympathetic activity such as RMSSD, pNN50, HF power, and HF nu were significantly low among the overweight individuals. SDNN and total power, measures of total HRV, were also significantly low among the overweight individuals, which could be due to the decreased

parasympathetic activity. Similar observation has been made in overweight men in the age group of 45–50 years, who have sympathovagal imbalance with predominant decrease in parasympathetic tone.[14] The increased sympathetic activity that is usually observed in obese individuals is not seen in overweight individuals.[15] Hence, it is evident that in overweight individuals, the cardiac parasympathetic withdrawal is responsible for the reduced total HRV, which may lead to various cardiovascular morbidities in future.

The study has some limitations. The sample size is smaller (N = 36). Increasing the sample size may lead to confirmatory findings especially with regard to frequency domain parameters indicative of sympathetic overactivity. Also, the study is limited to only male gender, due to which the findings cannot be generalized to the whole population.

Conclusion

Overweight individuals have altered cardiac autonomic status with reduced HRV. Hence, appropriate clinical investigations including HRV need to be done periodically in these individuals to prevent further derangement of the cardiac autonomic activity and future cardiovascular complications.

Acknowledgments

We thank Dr. Maruthi, Professor of Physiology, Narayana Medical College, Andhra Pradesh, India, for providing the ECG module for data acquisition.

References

1. Obesity and overweight. WHO, Fact sheet N°311, updated January 2015. http://www.who.int/mediacentre/factsheets/fs311/en/.
2. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363(9403):157–63.
3. Rajalakshmi R, VijayaVageesh Y, Nataraj SM, MuraliDhar, Srinath CG Heart rate variability in Indian obese young adults. Pak J Physiol. 2012;8(1):39–44.
4. Chethan HA, Niranjan Murthy Basavaraju K. Comparative study of heart rate variability in normal and obese young adult males. Int J Biol Med Res. 2012;3(2):1621–3.
5. Kim JA, Park YG, Cho KH, Hong MH, Han HC, Choi YS, et al. Heart rate variability and obesity indices: emphasis on the response to noise and standing. J Am Board Fam Pract. 2005;18(2): 97–103.
6. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. JAMA. 1999;282:1523–9.
7. Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Eur Heart J. 1996;17(3):354–81.
8. Koskinen T, Kähönen M, Jula A, Laitinen T, Keltikangas-Järvinen L, Viikari J, et al. Short-term heart rate variability in healthy young adults: the cardiovascular risk in young Finns Study. Auton Neurosci. 2009;145:81–8.
9. Colhoun HM, Francis DP, Rubens MB, Underwood SR, Fuller JH. The association of heart-rate variability with cardiovascular risk factors and coronary artery calcification: a study in type 1 diabetic patients and the general population. Diabetes Care. 2001;24(6): 1108–14.
10. Kleiger RE, Miller JP, Bigger JT, Moss AJ. Decreased heart rate variability and its association with increased mortality after acute myocardial infarction. Am J Cardiol. 1987;59(4):256–62.
11. Osula S, Bell GM, Hornung RS. Acute myocardial infarction in young adults: causes and management. Postgrad Med J. 2002;78:27–30.
12. Babu BV, Kusuma YS, Naidu JM. The influence of age, sex and obesity on blood pressure levels in a tribal population. Indian J Physiol Pharmacol. 1998;42(4):543–7.
13. Chintala KK, Krishna BH, N MR. Heart rate variability in overweight health care students: correlation with visceral fat. J Clin Diagn Res. 2015;9(1):CC06–8.
14. Pramodh V, Prashanth Kumar M, Krishna Prasad BA. Heart rate variability in overweight individuals. IOSR J Dental Med Sci. 2014;13(5):41–5.
15. Muralikrishnan K, Balasubramanian K, Ali SM, Rao BV. Poincare plot of heart rate variability: an approach towards explaining the cardiovascular autonomic function in obesity. Indian J Physiol Pharmacol. 2013;57(1):31–7.

How to cite this article: Ramalingam L, Ramesh R, Kuppan R. Assessment of cardiac sympathovagal activity in overweight young adult males. Natl J Physiol Pharm Pharmacol 2016;6:101-105

Source of Support: Nil, **Conflict of Interest:** None declared.