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RESEARCH ARTICLE

Gender differences in cardiovascular autonomic function status in normal healthy individuals: A cross-sectional study

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ABSTRACT

Background: The autonomic nervous system plays an important role for maintaining vital functions in our body. The balance between sympathetic and parasympathetic systems is essential in maintaining homeostasis. Heart rate variability (HRV) refers to the beat-to-beat variation in heart rate generated by the interplay of sympathetic and parasympathetic nerve activity at the sinus node of the heart. It has been used as a non-invasive tool to analyze the influence of the autonomic nervous system on the heart. The importance of HRV as a tool for assessing the autonomic nervous system activity in many different diseases and conditions has steadily increased. In addition to frequently used long-term HRV analysis, short-term HRV analysis has been increasingly applied due to its suitability for ambulatory care and short-term patient monitoring and due to the almost instant availability of test results. **Aims and Objectives:** This study aimed at finding out gender differences in cardiac autonomic function tests in normal healthy individuals. **Materials and Methods:** This cross-sectional study was done on 20 male and 20 female subjects. Ethical committee clearance was taken before the start of the study and written informed consent was obtained from every individual. HRV tests were computed by recording lead II electrocardiogram on RMS polyrite-D machine. It included frequency domain variables such as low-frequency (LF) band, the high-frequency (HF) band, and the LF/HF ratio and time domain parameters such as standard deviation of all RR intervals over the selected time intervals (SDNN) and root mean square of successive differences between adjacent RR intervals (rMSSD). The values were tabulated and statistical analysis was done using unpaired *t*-test. $P < 0.05$ was considered statistically significant and <0.001 as highly statistically significant. **Results:** In our study, all the frequency domain variables were relatively increased in males as compared to females except HF parameter, though statistically not significant. The values for rMSSD and SDNN were found to be relatively higher in females than males. **Conclusion:** This study suggests that there are gender differences in HRV in normal healthy individuals. A relatively increase in sympathetic drive in men could indicate an increased risk of cardiovascular diseases. However, such studies need to be done in larger group of population to get better results.

KEY WORDS: Gender; Autonomic Nervous System; Heart Rate Variability; Cardiovascular

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INTRODUCTION

The autonomic nervous system has got an immense importance for maintaining vital functions in our body such as blood pressure (BP), heart rate, temperature regulation, and gastrointestinal function. The functioning of autonomic nervous system is the balance between sympathetic and

parasympathetic nervous activity. This is very essential in maintaining the normal internal environment in the body and any disturbances in the balance between these two components of the autonomic nervous system hinder one's ability to overcome any disturbances in the environment.[1] The doctors have a key role in diagnosing the signs and symptoms of dysautonomia. The newer technologies and the availability of various techniques to determine autonomic function status have resulted in the availability of various tests which are readily accessible to the clinician.[2]

The sinus node of the heart generates beat-to-beat variation in the heart rate which is influenced by both sympathetic and parasympathetic nervous activity. Moreover, this variation is nothing but the heart rate variability (HRV).[3]

HRV tests are the simple methods which are used to do the analysis of influence of the autonomic nervous system on the heart.[4]

Last few decades have seen growing importance of HRV as an indicator of the functioning of the autonomic nervous system activity in various physiological and pathological conditions. Apart from using long-term HRV analysis, short-term HRV analysis has also been used routinely due to its feasibility and less time consumed in getting the results.[5] From among the various parameters, the high-frequency (HF) component of HRV is an indicator of parasympathetic control of the heart rate which is mediated through vagus, whereas the previous researches suggest that the low-frequency (LF) component is the marker for both sympathetic and parasympathetic influences or even a marker of sympathetic modulation. The LF/HF ratio is an indicator of balance between sympathetic and vagal activity.[6]

Various studies have been done in the past showing the effect of various physiological parameters such as aging, exercise, and physical training as well as various diseases on cardiac autonomic function status. However, very few studies have sought to determine the differences in the cardiovascular autonomic function status parameters between normal healthy males and females with conflicting opinions. The present study was, hence, carried out to determine the same and to correlate any gender-specific predominance of sympathetic and parasympathetic nervous system on sympathovagal functioning, if any.

MATERIALS AND METHODS

This cross-sectional study was done on 40 healthy age- and sex-matched subjects who were selected from teaching and non-teaching staff of Dr. D Y Patil Medical College, Pimpri, Pune. Of these 40 subjects, 20 were male and 20 were female subjects. Ethical committee clearance was taken before the start of the study and written informed consent was obtained from every individual.

Inclusion Criteria

Healthy males and females in the age group of 18–40 years were included in the study.

Exclusion Criteria

1. Patients having any type of cardiovascular diseases, respiratory diseases, neuromuscular and connective tissue disorders, or any other systemic disease/ailment.
2. Patients addicted to alcohol, smoking, tobacco, etc.
3. Patients on any kind of medications.
4. Female subjects during menstruation phase of the cycle.
5. Obese and underweight individuals.

All the subjects were explained the methodology in details and demonstration and trials were given wherever required.

The study was carried out in morning hours between 9 am and 11 am to maintain the constancy of the results. Subjects were prohibited from consuming alcohol, tea, coffee, or food before the study. A sociodemographic pro forma containing details such as age, sex, height, and weight was filled up. Height was calculated on barefoot with the help of stadiometer. Weight was measured by standardized weighing machine.

After that, body mass index (BMI) (kg/m^2) was calculated using the formula.

BMI = (Weight in kg)/(Height in meter).[2]

Then, these individuals were subjected to cardiovascular autonomic function tests. Cardiovascular autonomic function tests consisted of autonomic cardiovascular reflex tests and evaluation of HRV.[7] Of these, HRV tests were evaluated in this study. A rest of 10 min was given before starting the tests.

Evaluation of HRV

HRV tests were computed by recording lead II electrocardiogram on polyrite-D machine. It included frequency domain variables of HRV such as LF band, the HF band, and the LF/HF ratio. The time domain variables computed for each subject were standard deviation of all RR intervals over the selected time intervals (SDNN) and root mean square of successive differences between adjacent RR intervals (rMSSD).

The data were obtained separately for males and females and statistical analysis done using the SPSS ver.17. The values of these tests were compared between males and females by applying unpaired *t*-test and p value was obtained. $P < 0.05$ was considered statistically significant and <0.001 as highly statistically significant.

Table 1: Mean values of anthropometric parameters (mean±standard deviation)

Gender	Age in years	Height in cm	Weight in kg	BMI (kg/m^2)
Males	28.45±7.41	166.95±7.06	63.30±10.03	21.325±4.66
Females	34.05±4.40	155.78±3.82	55.68±6.00	19.84±2.05

BMI: Body mass index

RESULTS

Results are tabulated in Tables 1 and 2.

Table 2: Mean values of HRV parameters and their comparison in males and females (mean±standard deviation)

HRV parameters	Males	Females	*P* value
LF in m^2	436.15±309.52	392.4±264.24	0.33
LF nu	78.66±6.21	73.39±7.01	0.48
HF in m^2	135.5±85.10	159±94.42	0.36
HF nu	21.57±5.74	26.76±6.54	0.41
LF/HF ratio	3.31±1.07	2.44±0.70	0.35
LF/HF nu	3.95±1.27	2.92±0.83	0.36
SDNN in ms	38.45±14.60	43.32±16.52	0.43

P>0.05 is statistically insignificant, HRV: Heart rate variability, SDNN: Standard deviation of all RR intervals over the selected time intervals, LF: Low frequency, HF: High frequency

DISCUSSION

The previous studies have been done to compare the cardiovascular autonomic function tests in various disease conditions, but very few have been done on healthy individuals. Hence, the present study was carried out to compare the tests between males and females. HRV parameters reflect autonomic balance, regulation of BP, gut functioning, etc.[8]

Spectral analysis expresses heart rate as a function of frequency. The cyclical nature which is present in the series of changing RR intervals is revealed by this procedure. After measuring the frequency and magnitude of these oscillations, the calculation of the power density for separate frequency ranges is done. The two components which are commonly assessed are as follows:[7]

1. LF (component of the LF range, 0.04–0.15 Hz, which is influenced by both the sympathetic and parasympathetic nervous system)
2. HF (component of the HF range, 0.15–0.4 Hz, affected predominantly by the parasympathetic nervous system, affected by respiration and BP changes), and
3. LF/HF ratio.

Of the time domain parameters, SDNN is the parameter which denotes overall HRV and reflects both long- and short-term fluctuations in HRV,[9] whereas rMSSD estimates short-term components in heart rate and reflects parasympathetic influence.

Of all the tests for HRV, frequency domain variables analysis method is the common method of the analysis of HRV.[10]

In our study, all the frequency domain variables were relatively increased in males as compared to females except HF parameter, though statistically not significant. In the present study, the values for rMSSD and SDNN were found to be relatively higher in females than males though statistically insignificant.

As mentioned earlier, the HF band correlates with parasympathetic activity rather than the sympathetic one. It mainly corresponds to changes in the heart rate with respiratory cycle. Rather than indicator of cardiac sympathetic tone, LF power signifies baroreflex function.[11] Many drugs have been found to be affecting the cardiac autonomic functioning through modulation of outflows from baroreflexes. The LF/HF ratio indicates sympathetic activity.[12]

Thus, this study suggests that males have relatively sympathetic predominance, while females have relatively parasympathetic predominance though it is not statistically significant. The statistically insignificant values could be due to low sample size.

Variations in HRV parameters are seen in many pathological conditions and these conditions when elevate HRV parameters can lead to increased risk of autonomic dysfunction and ultimately morbidity and mortality.[13]

In a study done by Stein *et al*., in 2013, it was concluded that females have predominance of sympathetic activity as compared to males of the same age group and aging has got an effect on this activity.[14]

In one of the studies done previously, sample size was found to be less.[15] In a study conducted by Khan in healthy Pakistani individuals, the values of various parameters such as SDNN, the standard deviation of the 5-min average of N-N intervals in ms, and rMSSD have been described, but there is no description of other frequency domain parameters and also the gender differences.[16]

In a study done by Dutra *et al*.,[17] it was found that as compared to males, women had lower LF values, whereas the HF parameter value was higher. This study concluded that there is a difference between cardiac autonomic balance between

males and females and females have greater parasympathetic (vagal) influence as compared to men. These findings are similar to our study.

In a study done by Bhowmick *et al*., it was found that parasympathetic responses were more in males as compared to females, whereas sympathetic responses were also more in males and in some cases were more in females. However, the parameter studies were BP and heart rate responses to supine position at rest, standing position from supine, tilted supine position (head-up tilt) and Valsalva maneuver, isometric exercise, and cold pressor test.[18]

In one such similar study like the present one done by Kapoor *et al*., it was found that the males have higher sympathetic activity as compared to females. Higher levels of testosterone and catecholamines in them could be the reason for this.[19]

Findings of the study done by Nayak and Ray suggest that adult males have higher BMI and increase sympathetic reactivity and decrease parasympathetic reactivity than females of same age group. However, in the middle-aged group, there is no significant difference in autonomic reactivity between sexes. It may be due to the effect of estrogen on the vascular bed that disappears after menopause.[20]

In a study done by Zachariah and Joseph,[21] there was no statistically significant difference observed in HRV between males and females both in time domain and frequency domain analyses, but during mental stress, males showed sympathetic predominance.

Strength of the Study

Very few studies have been done to compare cardiovascular autonomic function tests in healthy individuals. As yet, standardized values for cardiovascular autonomic function tests for Indian population are not available. Hence, our study can provide supportive data for future research in this aspect.

Limitation of the Study

The study has been done with a small sample size. Other parameters such as cold pressor test and Valsalva maneuver need to be considered for comprehensive evaluation of cardiovascular autonomic function.

CONCLUSION

Thus, this study suggests that there are gender differences in HRV in normal healthy individuals. A relatively increased sympathetic drive in men could indicate an increased risk of cardiovascular diseases in them, and hence, preventive measures should be taken accordingly. However, such studies need to be done in larger group of population to get better results.

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