

Original Article

Power spectral analysis of heart rate variability in Bangladeshi healthy male and female

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Abstract

Heart rate variability (HRV) has been considered as an indicator of autonomic nerve function status. We aimed to find out the reference values of heart rate variability by power spectral analysis in our healthy population of both sex. This cross sectional study was conducted in the Department of Physiology, Dhaka Medical College, Dhaka from the period of July 2012 to June 2013. For this, 180 subjects were selected with the age ranging from 15-60 years. All the study subjects were divided into 3 different groups according to age (Group A: 15-30 years; Group B: 31-45 years; Group C: 46-60 years). Each group contained 60 subjects of which 30 were male and 30 were female. Analysis of HRV parameters were done in Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. Systolic blood pressure, diastolic blood pressure, low frequency normalized unit, low frequency / high frequency ratio were significantly higher in male than female. Again high frequency power, high frequency normalized unit were significantly higher in female than male of same age group. This study concludes that male showed higher cardiac sympathetic activities while female showed higher cardiac parasympathetic activities in different age groups.

Key words: Heart rate, male, female

Introduction

Sex is a biological fact and refers to biological and

physiological characteristics that determine men and women. There are hormonal, chromosomal and sex organ differences between them.¹ Biological functions may be different in both sexes due to their developmental differences or due to sex hormones.²

The autonomic nervous system (ANS) has two divisions that is sympathetic and parasympathetic. Both of these divisions regulate and modulate the cardiovascular function. Sympathetic part of it increases the heart rate and blood pressure (BP) on the other hand parasympathetic part decreases heart rate and BP.³

Heart rate variability (HRV) refers to the beat to beat variation in the heart rate generated by the interplay of the sympathetic and parasympathetic nerve activity at the sinus node of the heart.⁴ It is well recognized that cardiovascular functions vary both in male and females.⁵ There are evidences of sex difference in the autonomic control of heart due to effect of sex hormones and there is higher sympathetic response in males and higher parasympathetic response in females.²

Gender is an important predictor of baroreceptor sensitivity (BRS).⁶ It was also stated by some investigators that BRS was significantly higher in older men than in women. The mechanism responsible for this lower BRS in women may be due to sex hormone.⁷ Parasympathetic tone is more than sympathetic tone in younger women and reverse in men.⁸ Similar findings were stated by some other investigators in their study that sympathetic neural outflow was less in women as compared with men. Though the differences diminished after the age of 50 years.⁹ On the other hand opposite findings were also stated by some researchers, they found parasympathetic activity is more in males than females. It may be due to testosterone and muscular built of males that cause higher vagal tone.⁵ Again sympathetic dominance in Pakistani women than men was found by some investigators.¹⁰ Some study have also shown that vagal function was not significantly different between male and female but sympathetic activity was significantly higher in male compared to female.¹¹ Some recent study have shown that the influences of gender on age related changes in cardiac autonomic activity is not well established.¹⁰ Heart rate variability (HRV) reflects autonomic nerve function status. Normally HR variation is related to the balance between sympathetic &

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parasympathetic nervous system which provides early better qualitative and quantitative interpretation of sympathovagal activity and can detect autonomic impairment. High HRV reflects good adaptability and well functioning autonomic control. On the other hand, reduced HRV acts as a strong predictor of many cardiac diseases.¹²

Therefore, this study was carried out to assess the autonomic nerve function status in male and female to explore its role in occurrence of cardiovascular diseases and to utilize this background information in creating awareness to the clinicians for better management of the cardiac diseases.

Methods

This cross sectional study was carried out to observe the autonomic nerve function by power spectral analysis of HRV in 180 healthy male and female with age ranging from 15-60 years, in the department of Physiology, Dhaka Medical College from July 2012 to June 2013. For this, total study subjects were first divided into 3 groups according to their age (group A: 15-30 years, group B: 31-45 years, group C: 46-60 years). Each group was again divided into two subgroups A1 & A2; B1 & B2 and C1 & C2 containing equal number (30) of male and female respectively.

All the subjects were volunteers and selected from different areas of Dhaka city. They were free from heart disease, hypertension, diabetes mellitus, chronic renal failure, neurological disorders and smoking.

The subjects were thoroughly informed about the procedure of the study. They were allowed to withdraw themselves from the study whenever they liked. Informed written consent was taken in a prescribed form.

The subjects were advised to have their meal by 9:00 pm, to remain free from any physical or mental stress and not to take sedatives or any drugs affecting central nervous system at the night before the day of examination. The subjects were also asked to take light breakfast and to avoid tea or coffee at the time of breakfast. On the day of examination the subjects were advised to attend the Autonomic Nerve Function Test Laboratory in the Department of Physiology of Bangabandhu Sheikh Mujib Medical University between 9:00 to 11:00 am. Whenever the subject appeared in the department, he/she was interviewed and detail history regarding personal history, drug history, past medical history were taken. Then thorough physical examinations and anthropometric measurement including height, weight and BMI were taken. All information were recorded in a prefixed

questionnaire. Then he/she was kept in complete bed rest in supine position for 15-20 minutes in a cool and calm environment. During this period subject was advised not to talk, eat or drink and also not to perform any physical or mental activity, even sleep. Then all preparations for recording of the Heart rate variability parameters were made by connecting the channels to a transducer for ECG to a computerized polygraph and 5 minutes recording was taken in resting supine position. Data were obtained by software analysis of the power spectral band of the HRV (Task Force). Data were expressed as mean \pm SD. For statistical analysis, one way ANOVA, unpaired Student's 't'-test were performed by using SPSS (version-17) as applicable.

Results

In group A; the mean height, weight, LF (low frequency) norm, LF/HF ratio were significantly ($p < 0.001$) higher in group A1 than group A2. Again HF norm (high frequency), HF power were significantly ($p < 0.001$) higher in group A2 than that of group A1. (Table I)

In group B, the mean height, weight, were significantly ($p < 0.001$) higher in group B1 than group B2. But there was no significant difference was observed in TP (total power), LF power, HF power, LF norm, HF norm and LF/HF ratio between group B1 & B2. (Table II)

In group C, the mean height, weight, were significantly ($p < 0.001$) higher in group C1 than that of group C2. But there was no significant difference was observed in LF power, HF power, HF norm & LF/HF ratio except for TP (higher in C2) & LF norm (higher in C1) between these two groups. (Table III)

Discussion

In the present study, findings of HRV parameters in healthy male and female of different age group were almost within normal range and also similar to those reported by the various investigators of other countries and also our country.^{5,8,13,14-17} Different power spectral components of HRV has been used as marker of cardiac autonomic activity. The task force guideline for HRV analysis have demonstrated the interpretation of these parameters to understand the status, behavior and the balance between sympathetic and parasympathetic due to their continuous interaction. The total power represents the variability of R-R interval and is the result of the total cardiac autonomic nervous activities and hormonal activities on heart. Therefore its lower value indicates lower modulation of cardiac autonomic nervous activities on heart.⁴

Table-I: Study parameters in group A (n=60)

Parameters	A1(Male, n=30)	A2(Female, n=30)	p-value
Age (years)	24.40±3.66	25.97±3.56	0.098
Weight (kg)	56.97±6.32	50.73±4.46	< 0.001
Height (cm)	165.67±6.25	157.37±3.69	<0.001
BMI (kg/m ²)	20.67±1.30	20.43±1.13	0.443
Total power (ms ²)	2657.63±241.23	2706.83±255.79	.447
LF nu (ms ²)	56.97±2.87	53.90±1.86	<0.001
HF nu (ms ²)	30.03±7.95	37.90±8.80	.001
LF power (ms ²)	791.86±60.78	776.82±50.60	.302
HF power (ms ²)	432.15±123.63	596.78±170.14	<0.001
LF/HF	1.94±0.42	1.55±0.12	<0.001

Table-II: Study parameters in group B (n=60)

Parameters	B1(Male, n=30)	B2(Female, n=30)	p-value
Age (years)	35.53±3.73	34.97±3.24	0.532
Weight (kg)	59.80±4.85	54.73±2.69	<0.001
Height (cm)	166.00±5.43	160.00±2.60	<0.001
BMI (kg/m ²)	21.67±0.99	21.35±0.65	0.150
Total power (ms ²)	2617.67±215	2570.47±251.9	.438
LF nu (ms ²)	57.13±1.87	56.80±1.99	.506
HF nu (ms ²)	29.27±6.15	30.46±8.22	.527
LF power (ms ²)	825±103.32	799.56±82.22	.378
HF power (ms ²)	461.19±154.9	463.80±141.10	.946
LF/HF	1.96±0.39	1.92±0.42	.735

Table-III: Study parameters in group C (n=60)

Parameters	C1(Male, n=30)	C2(Female, n=30)	p-value
Age (years)	51.00±3.97	48.63±3.09	.013
Weight (kg)	61.23±4.39	54.10±4.04	<0.001
Height (cm)	167.50±3.77	159.30±3.71	<0.001
BMI (kg/m ²)	21.74±0.98	21.18±1.04	.036
Total power (ms ²)	2445.86±171.65	2549.36±227.93	.05
LF nu (ms ²)	58.80±0.41	57.83±1.42	.001
HF nu (ms ²)	23.86±2.65	24.07±1.76	.723
LF power (ms ²)	865.42±111.51	838.44±98.79	.325
HF power (ms ²)	397.25±97.25	393.73±98.14	.889
LF/HF	2.16±0.37	2.11±0.36	.582

Results are expressed as Mean ± SD.

P value measured by independent Student's 't' test

ms = squared millisecond

TP= Total power

LF = Low frequency.

HF = High frequency

LF (nu) = Low frequency in normalized unit.

HF (nu) = High frequency in normalized unit.

LF/HF = Ratio of low frequency and high frequency.

Group B1 = Male; Group B2 = female

Two major components of spectral band, HF power and HF nu reflect the parasympathetic modulation on the heart and the LF power represents the sympathetic activity on the heart; though, some investigators claimed that it is also under some parasympathetic contribution whereas LF nu emphasizes the controlled & balanced behavior of the sympathetic nervous system. The LF/HF ratio can be considered as a marker of their sympathovagal balance.⁴

In this study, Total power was significantly higher ($p<0.05$) in female than male was observed in group C

But no significant difference between male and female of same age group was found in LF power. Some investigators of other countries observed that the total power were significantly lower in post menopausal women compared to that of young women.¹⁸ Opposite findings were also observed by some investigators by analyzing of LF power of HRV in healthy adolescent & middle aged persons and found higher LF power in men than women.^{18,19} But others found that the gender differences were largely lost after the age of 55 years.⁸

In the present study, HF power of the HRV was significantly ($P<0.001$) higher in female than male of group A. But there was no significant difference was observed between male and female of group B and C. Similar observation was also reported by a large number of investigators of different countries.^{2, 18, 19} On the other hand decline of both LF and HF power with increasing age and the decline was more marked for men than women.²⁰

In case of LF norm, significant ($p<0.001$) difference was found between male and female of group A and C. But no difference was observed in male and female of group B. These findings are also consistent with the findings of most investigators in this field. But female has higher HF norm than male in group A and it was statistically significant ($p<0.001$). Almost similar type of findings of HF norm was also reported by other investigators.^{8,18}

In LF/HF ratio no difference was found in male and female except group A. Some investigators also showed that LF/HF ratio was significantly lower in adolescent and adult females compared to males of this age group.¹⁸ On the contrary some did not found any significant change in LF/HF ratio especially in men until the age of 60 years.⁸

Many explanations are suggested by different investigators for this involvement of cardiac autonomic nerve function in sex differences. Though the exact mechanisms are not yet clear, these changes may occur due to: difference in

their gonadal hormone level. Estrogen stimulates parasympathetic nervous system while testosterone stimulate sympathetic nervous system.^{2,6,7,21} But the exact mechanisms is not elucidated as the serum and urinary catecholamine, estrogen and testosterone hormone levels were not assessed in the present study due to some limitations.

From this study it may be concluded that variation of cardiac autonomic nerve function can occurs in sex differences which is characterized by higher cardiac sympathetic activity in male while higher cardiac parasympathetic activities in female.

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