POWER SPECTRAL ANALYSIS OF HEART RATE VARIABILITY IN BANGLADESHI HEALTHY POPULATION OF DIFFERENT AGE

QAZI FARZANA AKHTER[1], QAZI SHAMIMA AKHTER[2], FARHANA RAHMAN[3], SYBYLA FERDOUSI[4], SUSMITA SINHA[5]

[1]Assistant Professor, Department of Physiology, Uttara Adhunik Medical College, Dhaka
[2]Professor and Head, Department of Physiology, Dhaka Medical College, Dhaka
[3]Assistant Professor, Department of Physiology, Delta Medical College, Dhaka
[4]Assistant Professor, Department of Physiology, University Dental College, Dhaka
[5]Assistant Professor, Department of Physiology, Nightingale Medical College, Dhaka

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 different age. 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. The subjects were selected from different areas of Dhaka city by personal contacts. Analysis of HRV parameters were done in Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. For statistical analysis, one way ANOVA, unpaired Students t-test and Pearson's correlation coefficient test were performed by using SPSS (version-17) as applicable. LF nu, LF power and LF/HF were significantly ($p<0.001$) higher in group C in comparison to those of group A and B. Again Total power, HF power, HF nu ($p<0.001$) were significantly higher in group A and B in comparison to that of group C. This study concludes that cardiac parasympathetic activity was decreased and sympathetic activity was increased with aging.

Key words: *HRV, LF, HF, LF nu, HF nu, LF/HF.*

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INTRODUCTION

Aging is a gradual, continuous process of spontaneous changes, begins at birth and continues throughout the life. It involves maturation and development for children, adolescents and young adults. Then again many biological functions decline during middle and late age. Thus aging has both positive and negative aspects.[1]Aging is inevitable and as life expectancy increases day by day it become more important to understand the physiological mechanism associated with normal aging process.[2]

Aging is a general physiological process that is yet poorly understood. Aging affects cells, tissues and organ systems. With aging normal cells stop divisions and eventually die under genetic control.[3] With the advancement of age, there is a gradual decrease in body functions affecting mostly cardiovascular, respiratory, renal and nervous system including autonomic nerves.[4]

Address of Correspondence: Qazi Farzana Akhter, Assistant Professor, Department of Physiology, Uttara Adhunik Medical College, Dhaka

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.[5]

Normal human aging is associated with changes in the autonomic control of several biological functions. The two components of ANS changes with age, but the degree of changes with aging is different because of their divergent neural pathway.[6] Aging alters the neurohormonal mechanism and causes a decline of SA nodal parasympathetic activity. That is why reduction of parasympathetic activity occurs with age.[7]

In advanced age due to impairment in the parasympathetic control of heart, there are increased risk of cardiovascular diseases, like arrhythmia and sudden cardiac death. So in elderly parasympathetic dysfunction shows altered sympathovagal activity and abnormal heart rate.[8]

Heart rate variability (HRV) reflects autonomic nerve function status. Normally HR variation is related to the balance between sympathetic & 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.[9]

Power spectral analysis of HRV can demonstrate definite impairment in cardiac autonomic control. Power spectral component of HRV analysis includes Total power, VLF power, LF power, HF power, LF norm, HF norm and LF/HF ratio.[5]

Lower values of total power, HF power, LF power, HF norm were reported by various investigators of different countries in old age in comparison to young age.[10-15] Again higher LF norm and LF/HF ratio were observed by some investigators with aging.[10.12] On the other hand higher HF nu was found in younger age.[11]

Therefore, this study was carried out to assess the autonomic nerve function status in different age and sex to explore its role in occurrence of cardiovascular diseases. The results can be utilized as background information in creating awareness to the clinicians for better management of the cardiac diseases.

MATERIALS AND METHODS

This cross sectional study was carried out to observe the autonomic nerve function by power spectral analysis of HRV in 180 healthy subjects 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 divided into 3 groups according to their age (group A: 15-30 years, group B: 31-45 years, group C: 46-60 years) All the subjects were selected by personal contact from different areas of Dhaka city. All the subjects were free from heart disease, hypertension, diabetes mellitus, chronic renal failure, neurological disorders and smoking.

After selection, the subjects were thoroughly informed about the objectives and detail procedure of the study. They were encouraged for voluntary participation and allowed to withdraw themselves from the study whenever they liked. If they agreed to enroll to the study, informed written consent was taken in a prescribed form. Night before the day of examination 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. 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 subject was 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 on the day of examination.

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 the subject was prepared to perform Autonomic Nerve Function Test. The subject 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 ±SD. For statistical analysis, one way ANOVA, unpaired Student's 't'-test and Pearson's correlation coefficient test were performed by using SPSS (version-17) as applicable.

RESULTS

The results of age and BMI are shown in Table I

The Mean age and BMI were significantly ($p< 0.001$) higher in group B and C than that of group A. So the groups were not matched for age and no significant difference of BMI was found between group B and C.

The mean total power, HF power, HF nu ($p<0.001$) of the subjects were significantly lower in group C than group A and B. Again LF power, LF nu, and LF/HF ratio ($p<0.001$) were significantly higher in group C than that of group A and B. (Table II & III).

Table I: **Age and BMI in different groups (n=180)**

Groups	***Age (yrs)***	
A(n=60)	25.18±3.67 (15-30)	20.55±1.21 (18.55-22.56)
B (n=60)	35.25±3.48 (31-45)	21.51±0.85 (19.03-23.0)
C(n=60)	49.82±3.73 (46-60)	21.46±1.04 (18.36-23.52)

Statistical analysis

Groups	Age(p value)	BMI (p value)
A vs B vc C[a]	<.001	< 0.001
A vs B[b]	<.001	< 0.001
A vs C[b]	<.001	< 0.001
B vs	<.001	0.797

Results are expressed as Mean ± SD. Figures in parentheses indicate ranges.

Statistical analysis were done by One-way ANOVA[a] and unpaired Student's 't' test[b]

The test of significance was calculated and p values < 0.05 was accepted as level of significance.

BMI = Body Mass Index

Group A: (15-30 years)

Group B: (31-45 years)

Group C: (46-60 years

n = Number of subject

Table II: **Power Spectral parameters of HRV in different groups (n=180)**

Groups	n	TP (ms^2)	LF power (ms^2)	HF power (ms^2)
A	60	2682.23±247.74 (2258-2965)	780.28±48.55 (722.32-1011.0)	514.47±169.21 (321.95-833.25)
B	60	2594.07±233.44 (2100-2895)	812.61±93.49 (695.74-1000.0)	462.49±146.95 (295.37-764.45)
C	60	2496.38±205.40 (2100-2800)	851.93±105.33 (730.53-1021.0)	395.50±96.88 (265.85-659.01)

Statistical analyses

Groups			
A vs B vs C	<0.001	<0.001	<0.001
A vs B[b]	0.04	0.04	0.04
A vs C[b]	<0.001	0.01	<0.001
B vs C[b]	0.02	0.01	0.01

Results are expressed as Mean ± SD. Figures in parentheses indicate ranges.

Statistical analyses were done by One-way ANOVA[a] and unpaired Student's 't' test[b] was performed for comparison between the groups.

The test of significance was calculated and p values < 0.05 was accepted as level of significance.

TP = Total power n = Number of subjects.

LF power = Low frequency power

HF power= High frequency power

ms^2 = squared millisecond

Group A: (15-30 years)

Group B: (31-45 years)

Group C: (46-60 years)

Table III: Spectral parameters of HRV in different groups (n=180)

Group	n	LF norm(nu)	HF norm(nu)	LF/HF
A	60	55.43±2.85 (51.00-59.00)	33.96±9.21 (22.00-54.00)	1.75±0.36 (1.34-3.01)
B	60	56.97±1.92 (52.00-59.00)	29.86±7.22 (22.00-50.00)	1.94±0.40 (1.49-3.34)
C	60	58.45±0.85 (55.00-59.00)	23.63±1.81 (22.00-33.00)	2.13±0.36 (1.68-2.88)

Statistical analysis

Groups			P value
A vs B vs	<0.001	<0.001	<0.001
A vs B[b]	<0.001	<0.001	<0.001
A vs C[b]	<0.001	<0.001	<0.001
B vs C[b]	<0.001	<0.001	<0.001

Results are expressed as Mean ± SD. Figures in parentheses indicate ranges.

Statistical analyses were done by One-way ANOVA[a] and unpaired Student's ' t' -test[b] was performed for comparison between the groups.

LF (nu) = Low frequency in normalized unit.

HF (nu) = High frequency in normalized unit.

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

Group A: (15-30 years)

Group B: (31-45 years)

Group C: (46-60 years)

n = Number of subjects

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.[11,12,14,16,17,18-20,26] 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.[5]

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.[5]

The cardiac sympathetic and parasympathetic activities are always in interaction. The LF/HF ratio can be considered as a marker of their sympathovagal balance.[5]

In this study, significantly lower Total power, HF power and HF nu in older person suggested lower parasympathetic activity and higher values of LF power, LF nu indicate higher sympathetic activity occurred with the advancement of age which are similar to those reported by some investigators of different countries.[10-14]

In addition higher sympathovagal balance with aging shows predominance of sympathetic activity in this group of subject.[11, 12]

Many explanations are suggested by different investigators for this involvement of autonomic nerve function activity in aged person though the exact mechanisms are not yet clear. These changes may occur due to**:** structural & functional changes of SA node, progressively decreased baroreceptor sensitivity (BRS), decrease in the compliance of large elastic arteries and also decreased vascular wall receptor sensitivity, moreover aging itself stimulates adrenergic nervous system.[7,21-25] But all of them were not possible to study due to some limitations.

CONCLUSION

From this study it may be concluded that cardiac autonomic nerve function impairment occurs with the advancement of age which is characterized by markedly decreased cardiac parasympathetic and increased sympathetic activities with aging and shifting of sympathovagal balance towards sympathetic predominance in advanced age.

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