Original Article

Time Domain Measures of Heart Rate Variability to Assess Cardiac Autonomic Nerve Function in Adult Bangladeshi Male and Female

Qazi Farzana Akhter[1], Qazi Shamima Akhter[2], Masuma Akhtar Banu[3],Matia Ahmed[1], Farhana Naznen[4]

Abstract

Background: Heart rate variability (HRV) has been considered as an indicator of autonomic nerve function status. ***Objective:*** To find out the reference values of heart rate variability by time domain measures of HRV inadult Bangladeshi population of both sexes. ***Methods:*** This cross-sectional, analytical study was conducted between July 2012 and June 2013. A total of 180 subjects were selected through the Department of Physiology, Dhaka Medical College Dhaka, Bangladesh, with the age ranging from 18 to 60 years. All the study subjects were divided into 3 different groups: group A (18-30 years), group B (31-45 years) and group C (46-60 years). Each group had 60 subjects: 30 males and 30 females. The experimentation of HRV parameters and recording of data were done using RMS Polyrite D (version 2.4) in Autonomic Nerve Function Test Laboratory of the Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. Mean systolic and diastolic blood pressure, heart rate along with R-R interval between successive QRS complexes, standard deviation of NN interval (SDNN), RMSSD (square root of mean squared differences between adjacent NN intervals) were observed and analyzed. ***Results:*** Systolic and diastolic blood pressure and RMSSD were significantly higher in males than that of females in all three groups ($P<0.001$). However, no differences were observed in mean heart rate, R-R interval, and SDNN between males and females in any group. ***Conclusion:*** Our data suggest that males have higher cardiac sympathetic activities, while females show higher cardiac parasympathetic activities in different age groups in terms of heart rate and blood pressure regulation. The difference of blood pressure is statistically significant; however, the difference of mean heart rate is not statistically significant.

Keywords: Heart rate, autonomic nerve function, male, female, Bangladeshi population

International Journal of Human and Health Sciences Vol. 06 No. 04 October'22 Page : 393-397
DOI: http://dx.doi.org/10.31344/ijhhs.v6i4.478

Introduction

Both sympathetic and parasympathetic divisions of the autonomic nervous system (ANS) in humans regulate and modulate the cardiovascular function.[1] Sympathetic part of it increases the heart rate and blood pressure (BP) on the other hand parasympathetic part decreases heart rate and BP.[1,2] 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.[3] It is well recognized that cardiovascular functions vary both in male and females.[1,4-7] There are evidences of sex difference in the autonomic control of

1. Department ofPhysiology, Uttara Adhunik Medical College, Uttara, Dhaka-1230, Bangladesh.
2. Department of Physiology, Dhaka Medical College, Dhaka-1000, Bangladesh.
3. Department of Anatomy, Uttara Adhunik Medical College, Uttara, Dhaka-1230, Bangladesh.
4. Department of Physiology, Community Based Medical College, Bangladesh (CBMC,B), Winnerpar, Mymensingh-2200, Bangladesh.

Correspondence to: Dr. Qazi Farzana Akhter, Associate Professor, Department of Physiology, Uttara Adhunik Medical College, Uttara, Dhaka-1230. Bangladesh. Email: qfarzanaakhter@gmail.com

heart due to effect of sex hormones and there is higher sympathetic response in males and higher parasympathetic response in females.[4-7] Gender is also an important predictor of baroreceptor sensitivity (BRS).[7,8]Research revealed that BRS is significantly higher in older men in comparison to itscounterpart. The mechanism responsible for this lower BRS in women may be due to sex hormone.[8,9]Moreover, parasympathetic tone is more than sympathetic tone in younger women and sympathetic neural outflow is less in women as compared with men.[9-12]The reverse is true for men, which may be due to testosterones and muscular built of males that cause higher vagal tone.[9-12]However, the difference diminishes after the 5th decade of life.[9] Some other studies have shown that vagal function is not significantly different between males and females, but sympathetic activity is significantly higher in maleswhen compared to females.[10,11]Heart rate variability (HRV) reflects autonomic nerve function status.[3,12] Normallyvariation in heart rate is related to the balance between sympathetic and parasympathetic nervous system which provides early better qualitative and quantitative interpretation of sympatho-vagal activity and can detect autonomic impairment.[3]Moreover, HRV represents a non-invasive, pain free, economic and simple measurement which help us understand a range of information provided by the numerous HRV parameters.[13]High HRV reflects good adaptability and well-functioning autonomic control.[3,12,13] On the other hand, reduced HRV acts as a strong predictor of many cardiac diseases.[3,12,13]Hence, this study was proposed to assess the autonomic nerve function status through heart rate variability in males and femalesin a Bangladeshi adult population to explore its role in health and disease and to an information pool toraisemore awareness among clinicians for better management of the cardiac diseases in clinical practice.

Methods

This cross-sectional, analytical study was carried out to observe the autonomic nerve function by power spectral analysis of HRV in 180 healthy adult Bangladeshi people with age ranging from 18 to 60 years, between July 2012 and June 2013. For this, total study subjects were first divided into 3 age-groups: group A: (18-30 years), group B (31-45 years), and group C (46-60 years). Each group was again divided into two subgroups, i.e. A1 & A2, B1 & B2, and C1 & C2 containing equal number (30) of males and females respectively. All the subjects were volunteers and selected from different areas of Dhaka city through the Department of Physiology, Dhaka Medical College, Dhaka, Bangladesh. They were free from any known heart disease, hypertension, diabetes mellitus, kidney disease, neurological and psychiatric disorders, and smoking. The subjects were thoroughly informed about the procedure of the study. They were allowed to withdraw themselves from the study wheneverthey liked. Informed written consent was taken. We adopted the standard recommended procedure suggested by the task force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology.[14]The recommendations were very useful and provided information on which HRV parameters to take into account and what their significance is at the physiological level. Accordingly, 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 the examination, the subjects were advised to attend the Autonomic Nerve Function Test Laboratory in the Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, between 9:00 and 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, e.g.,height and weight were recorded. Then BMI was calculated. 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. The experimentation and recording of data were done usingRMS Polyrite D (version 2.4). Data were obtained by software analysis of the power spectral band of the HRV. Data were expressed

as mean±SD. For statistical analysis, unpaired Student's 't'-test was performed. P value <0.05 was considered as statistically significant.All the analyses were done using the SPSS version17.0for Windows (SPSS Inc., Chicago, Illinois, USA).

Results

The mean height, weight, systolic and diastolic blood pressure andRMSSD were significantly higher in group A1 than that of group A2(P<0.001). Again,the mean R-R interval was higher in group A1 than that of group A2, while heart rate and SDNN were higher in group A2 than that of group A1. However, the differences were notstatistically significant (P>0.05)(Table 1). Similarly,the mean height, weight, systolic and diastolic blood pressure, and RMSSDwere significantly higher in group B1 than that of group B2(P<0.001). However,no significant differences were observed in mean RR interval, heart rate and SDNNbetween males and females(P>0.05)(Table 2) The mean height, weight, systolic and diastolic blood pressure, and RMSSDwere significantly higher in group C1 than that of group C2 (P<0.001). The mean R-R interval was higher in group C1 than that of group C2, and heart rate and SDNN were higher in group C2 than that of group C1,the differences were statistically not significant though(P>0.05) (Table 3).

Table 1. Study parameters in group A (n=60)

Parameters	A1(n=30)	A2(n=30)	P value
Age (years)	24.40±3.66	25.97±3.56	>0.05
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/m2)	20.67±1.30	20.43±1.13	>0.05
Pulse (beats/m)	73.70±6.90	72.73±3.97	>0.05
SBP (mm of Hg)	116.17±4.86	108.33±5.31	<0.001
DBP (mm of Hg)	76.50±4.39	70.67±4.50	<0.001
Mean RR (sec)	0.80±0.11	0.76±0.12	>0.05
Mean heart rate			
(beats/m)	76.30±10.01	79.87±11.42	>0.05
SDNN (ms)	74.88±20.65	77.35±16.68	>0.05
RMSSD (ms)	101.67±14.45	80.62±21.62	<0.001

Results are expressed as Mean±SD; P value reached from unpaired Student's 't' test

SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure

R-R = Interval between successive QRS complex (sec),

SDNN = Standard deviation of NN interval

RMSSD =Square root of mean squared differences between adjacent NN intervals

Group A1 = Male; Group A2= Female

Table 2. Study parameters in group B (n=60)

Parameters	B1(n=30)	B2(n=30)	P value
Age (years)	35.53±3.73	34.97±3.24	>0.05
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	>0.05
Pulse (beats/m)	72.53±5.22	73.80±5.80	>0.05
SBP (mm of Hg)	116.67±4.79	110.83±6.96	<0.001
DBP (mm of Hg)	76.00±5.32	72.50±4.31	<0.001
Mean RR (sec)	0.80±0.11	0.78±0.09	>0.05
Mean heart rate (beats/m)	76.43±8.82	77.93±7.5	>0.05
SDNN (ms)	76.10±15.94	78.20±19.03	>0.05
RMSSD (ms)	97.55±16.64	72.03±14.68	<0.001

Results are expressed as Mean±SD; P value reached from unpaired Student's 't' test

SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure

R-R = Interval between successive QRS complex (sec),

SDNN = Standard deviation of NN interval

RMSSD =Square root of mean squared differences between adjacent NN intervals

Group B1 = Male; Group B2= Female

Table 3. Study parameters in group C (n=60)

Parameters	C1(n=30)	C2(n=30)	P value
Age (years)	51.00±3.97	48.63±3.09	>0.05
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	>0.05
Pulse (beats/m)	74.80±6.65	75.60±6.66	>0.05
SBP (mm of Hg)	121.67±6.21	114.50±8.34	<0.001
DBP (mm of Hg)	79.83±6.50	73.00±5.87	<0.001
Mean RR (sec)	0.78±0.10	0.79±0.10	>0.05
Mean heart rate (beats/m)	80.43±7.76	81.87±8.97	>0.05
SDNN (ms)	67.97±19.51	74.62±16.69	>0.05
RMSSD (ms)	83.84±14.98	60.98±13.40	<0.001

Results are expressed as Mean±SD; P value reached from unpaired Student's 't' test

SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure

R-R = Interval between successive QRS complex (sec), SDNN = Standard deviation of NN interval
RMSSD =Square root of mean squared differences between adjacent NN intervals
Group C1 = Male; Group C2= Female

Discussion

The importance of heart rate variability (HRV) as a tool for assessing the autonomic nervous system activity in many different diseases and conditions has steadily increased in recent times.[2,13]In the present study, HRV parameters in healthy male and female of different age group were almost within normal range; differences were observedwith a higher blood pressure in males in comparison to its female counterpart. Our results arevery similar to those reported by the various investigators in the western countries.[4-7,10,12]Researchers from South Asia region also published similar reports on heart rate variability in respect of age and sex.[9,11,15-17]Similarobservations were reported by the researchers in our country.[18-22]Different timedomain components of HRV has been used as marker of cardiac autonomic activity.[13] The task force guideline for HRV analysis have demonstrated the interpretation of these parameters to understand the status, behaviour and the balance between sympathetic and parasympathetic due to their continuous interaction.[13] 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.[14]

In the present study, the mean heart rate and SDNN were higher in females than males in all age groups, but the differences were statistically not significant. Many explanations are suggested by different investigators for this involvement of cardiac autonomic nerve function in sex differences.[4-10] Though the exact mechanisms are not clear to date, gender differences in the autonomic nervous functions may be due to developmental differences or due to the effects of prevailing levels of male and/or female sex hormones.[7] Such prevailing hormone levels may also produce differences between pre- and post-menopausal women and amongst pre-menopausal women at different phases of the menstrual cycle.[1,7,23]However,in our study, the exact endocrine mechanisms is not elucidated as the serum and urinary catecholamines, oestrogen and testosterone hormone levels were not assessed due to time and budget constraint.

Conclusion

To summarize, variation of cardiac autonomic nerve function may occur between sexes, which is characterized by the higher cardiac sympathetic activity in malesand the higher cardiac parasympathetic activities in females. The difference of blood pressure is statistically significant in between sexes; however, the difference of mean heart rate is not statistically significant.

Acknowledgement: The authors of this study are thankful to the authority of Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, for the technical support in experimentation and recording of data usingRMS Polyrite D (version 2.4) in its Autonomic Nerve Function Test Laboratory.

Conflict of interest: The authors declare no conflict of interest.

Ethical approval: The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh.

Funding statement: Nil.

Authors' contribution: Concept and design of the study: QFA, QSA; Subject selection and data collection: QFA, MAB, MA, FN; Data analysis: QFA, MAB; Manuscript writing, revision and finalizing: QFA, QSA, MAB, MA, FN.

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