

## POWER SPECTRAL ANALYSIS OF HEART RATE VARIABILITY IN HEAVY WORKERS

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### Abstract

**Introduction:** Sedentary life style deteriorates Cardiac autonomic nervous activities (CANA). Regular physical activity may improve CANA.

**Objective:** Heart rate variability (HRV) was analyzed by Power Spectral method in heavy workers to find out the influence of regular physical activity on CANA.

**Methods:** This cross sectional study was carried out on 30 heavy workers aged 28-50 years (study group), at the Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU) over a period of 1 year. Simultaneously 30 sedentary workers of high socioeconomic status (group C) were studied to observe the influence of socioeconomic condition on heart rate variability (HRV). For comparison thirty age, sex, body mass index (BMI) and socioeconomic condition matched apparently healthy sedentary subjects (control) were also studied. The study subjects were selected from rickshaw-pullers living in the slum area nearby the university and the controls from fourth class employee of the university. Group C were selected from the doctors serving in the university and some from personal contacts. Total power, low frequency (LF) power, high frequency (HF) power, LF nu (neutralized unit), HF nu and LF/HF ratio were assessed and analyzed by a Polygraph. For statistical analysis, one way analysis of variance (ANOVA), Independent-samples t-test and Pearson's correlation coefficient tests were done.

**Results:** Total power, HF power and HF nu were significantly ( $p < 0.001$ ) higher and LF power, LF nu and LF/HF ratio were significantly ( $p < 0.001$ ) lower in heavy workers than those of sedentary subjects. Total power and HF nu showed positive correlations and LF nu and LF/HF ratio showed negative correlation with duration of works per day but all these correlations were statistically non-significant.

**Conclusion:** Regular physical activity improves cardiac autonomic nerve function status with a cardiac parasympathetic predominance.

**Key words :** Power spectral analysis (PSA), cardiac autonomic nervous activities (CANA), heavy workers, sedentary workers

### Introduction

The World Health Organization (WHO) defined physical activity as any bodily movement produced by skeletal muscle that requires energy expenditure<sup>1</sup>. Workers are classified as sedentary (office worker, teacher, lawyer, doctor etc), moderately active (Postman, bus conductor, plumber, light industrial worker etc) and very active (coal miner, forestry worker, rickshaw puller etc)<sup>2,3</sup>. Regular physical activity provides enormous health benefits. It is a key determinant of energy expenditure. Several studies confirmed overall health benefits of physical activity. Regular physical activity reduces the risk of cardiovascular diseases, stroke, type 2 diabetes mellitus, colon cancer, breast cancer etc<sup>1,4-8</sup>. In addition, globally 1.9 million deaths related to low physical activity has been reported by WHO<sup>1</sup>. Increased adiposity, high lipid profile and increased insulin resistance may have been considered as link between physical inactivity and coronary heart diseases. Disturbances in autonomic nerve function may be associated with people engaged in low physical activity<sup>9</sup>. Both structured and non-structured physical activity can act as a preventive therapy for cardiovascular diseases<sup>10</sup>.

Heart rate variability (HRV) is a conventionally accepted method to describe variations of both instantaneous heart rate and R-R intervals. Evidences from different studies indicate association between risk of lethal arrhythmias and increased sympathetic or reduced parasympathetic activities. It reflects the importance of examination of autonomic nerve function<sup>11</sup>. HRV analysis, a unique tool for quantitative measurement of cardiac autonomic activity has gained world wide acceptance. Currently analysis of HRV by simple time domain method, statistical time domain method and power spectral analysis (PSA) method is widely practiced. PSA includes total power, low frequency power (LF) and high frequency power (HF). The frequency measures are expressed in power spectral density<sup>11</sup>. For duration of ECG recording, Task Force has recommended a short term (5 minute) recording used in spectral analysis. Changes in autonomic modulation of HRV lead to variation in the distribution of total power, LF power and HF power<sup>11</sup>. HRV, at rest is an indicator of the interaction between cardiac sympathetic and parasympathetic

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activity. It is also responsible for beat to beat variability and for change in the frequency component of heart rate. It has been reported that decreased parasympathetic activity and increased sympathetic activity may reduce beat to beat variability. Research evidences suggest that sedentary life style may induce a reduction in parasympathetic outflow along with an increase in sympathetic outflow and it is associated with lower heart rate variability (HRV) with increased incidence of coronary heart diseases<sup>9,12,13</sup>. Conversely, vigorous activity is associated with increased parasympathetic activity and thereby with higher heart rate variability<sup>9,14,15</sup>.

In PSA higher total power, HF power and HF neutralized (nu) unit and lower LF power, LF nu, and LF/HF ratio in heavy workers than those of sedentary group were reported by some investigators from different countries<sup>9,16-21</sup>. But some investigators found opposite findings<sup>22-25</sup>. However, some researchers failed to find any change of these parameters due to heavy physical activity<sup>23,26-29</sup>. Mechanical and sedentary life style of this country, especially in urban area is increasing day by day. From the above mentioned information, it is more or less accepted that alteration of HRV parameters were mostly in favour of physically active people, though controversy of this finding were also found. In this country, study of regular physical activity on cardiac autonomic nerve function status by one investigator created some awareness of the benefit of physical activity<sup>30</sup>. This information may also help to reduce the cardiovascular morbidity and mortality and to raise consciousness in general population, especially sedentary people of higher socioeconomic status.

This study was carried out to compare the cardiac autonomic nerve function status by analyzing the HRV of heavy workers with low socioeconomic status, by microcomputer based frequency domain method.

### Materials and Methods

This cross-sectional study was carried out in the department of Physiology of Bangabandhu Sheikh Mujib Medical University (BSMMU) from July 2008 to June 2009. Departmental Ethical Committee approved the protocol. Thirty apparently healthy male heavy workers of low socioeconomic status, age ranged from 28-50 years were selected as study group (Group B), another 30 sedentary workers of high socioeconomic status and of same age group were also studied to observe the influence of socioeconomic status (Group C) and 30 age, sex and body mass index (BMI) matched sedentary workers of low socioeconomic status were selected as control group (Group A). Control subjects were selected from the fourth class employee of BSMMU and Group B from slum area nearby BSMMU. Group C were selected from the doctors serving in BSMMU and some from

personal contacts. The subjects were excluded from the study for any subject suffering from systemic diseases, obesity, psychic disorder and drug users specially drug affecting nervous system. A written informed consent was taken from each subject and their authority. The subject was also asked to avoid tea or coffee at breakfast and to attend at the Autonomic Nerve Function Test Laboratory between 9:00 am to 11:00 am on the day of examination. Then each subject was kept under complete bed rest in supine position for 20 minutes in a cool and calm environment at "Autonomic Nerve Function Test Laboratory" of the department of Physiology. During this period the subject was restricted to talk, eat, drink, any physical or mental activity and even sleep. All preparations for recording of the HRV parameters were made by connecting the channels for electro-cardiogram (ECG) of a Polygraph (RMS INDIA Version- 2.2). A five minutes ECG recording was taken in resting supine position and the frequency domain measures of the HRV i.e. Total power, LF power, HF power, LFnu, HFnu and the LF/HF ratio were obtained from the time series. All data were recorded systematically in preformed data collection sheet and were expressed as mean±SD. Statistical analysis was performed by using SPSS for windows version 12.0. One-way analysis of variance (ANOVA), Independent sample t-test and Pearson's correlation coefficient tests were performed as applicable. The p value < 0.05 was accepted as level of significance.

### Results

The anthropometric parameters of the subjects are presented in Table-I.

**Table-I:** Anthropometric measures (mean ± SD) in different groups (n=90)

Groups	Age (years)	BMI (kg/m <sup>2</sup> )
A (n=30)	35.03±6.44 (28 - 50)	21.10±2.45 (15.82-25.34)
B (n=30)	33.63±6.75 (28 - 50)	19.92±2.17 (16.14-26.92)
C (n=30)	36 ±4.89 (28 - 50)	22.79±2.01 (18.82-27.21)
Statistical analysis		
Groups	p value	
A vs B vs C	0.322	0.071
A vs B	0.414	0.135
A vs C	0.515	0.107

i Figures in parentheses indicate ranges.

Groups were matched for age and BMI. The mean value of total power and HF nu were significantly (p<0.001) higher and LF power, LF nu and LF/HF ratio were significantly (p<0.001) lower in group B than that of group A (Table II and III).

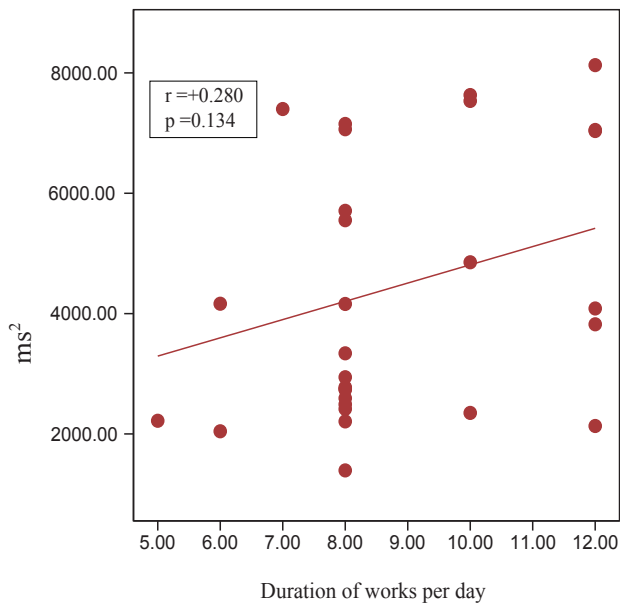
**Table-II:** Heart rate variability parameters (mean±SD) by frequency domain method in different groups (n=90).

Groups	Total power (ms <sup>2</sup> )	LF power (ms <sup>2</sup> )	HF power (ms <sup>2</sup> )
A (n=30)	2491±1492	399.3±266.5	150.1±91.9
B (n=30)	4426.4±2184.6	235.1±220.3	480.4±318
C (n=30)	2271.7±1547.2	356±278.8	151.8±123.7
Statistical analysis			
Groups	p value		
A vs B vs C	0.000	0.000	0.000
A vs B	0.000	0.000	0.000
A vs C	0.839	0.963	0.578

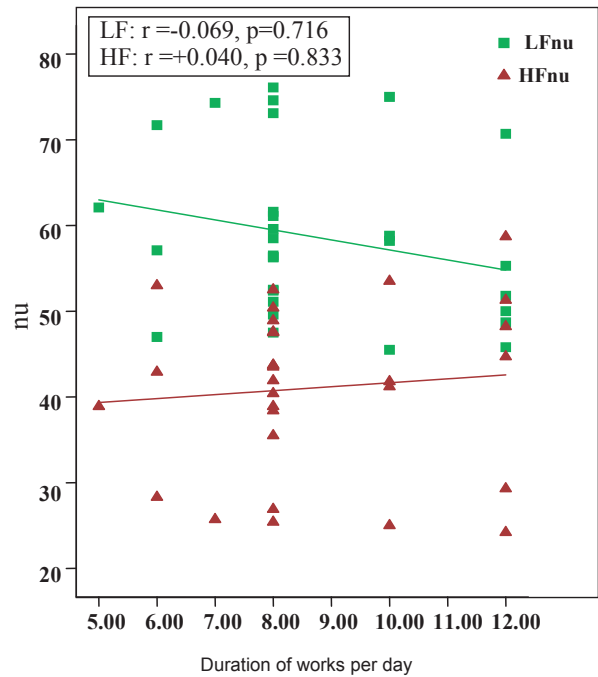
**Table-III:** Heart rate variability parameters (mean ± SD) by frequency domain method in different groups (n=90).

Groups	LF nu	HF nu	LF /HF
A (n=30)	73.38±6.19	26.13±5.66	3.03±0.82
B (n=30)	59.63±9.80	40.73±9.25	1.59±0.70
C (n=30)	77.75±3.82	23.29±5.86	3.37±0.65
Statistical analysis			
Groups	p values		
A vs B vs C	0.000	0.000	0.000
A vs B	0.000	0.000	0.000
A vs C	0.149	0.061	0.081

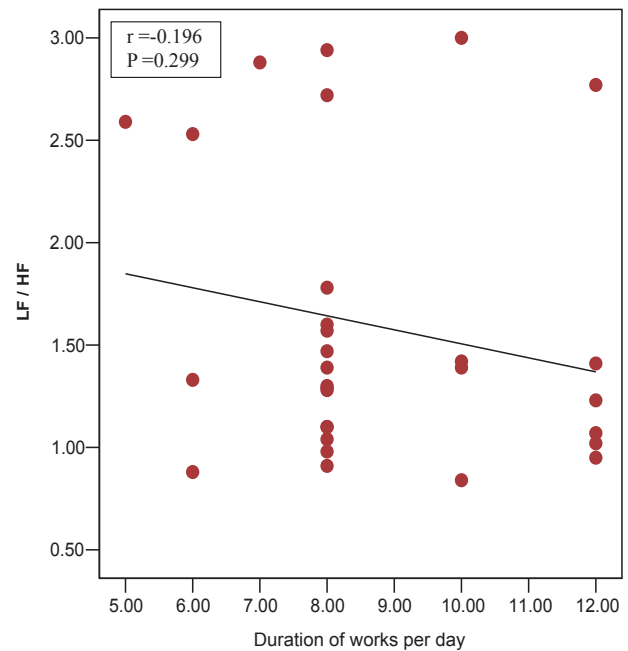
Total power ( $r= +0.280$ ) and HF nu ( $r=+0.040$ ) showed positive correlations; on the other hand, LF nu ( $r=-0.069$ ) and LF/HF ratio ( $r=-0.196$ ) showed negative correlation with duration of works per day in group B, but all these correlations were statistically non-significant.



**Fig-1:** Correlation of total power with duration of works per day in group B (n = 30)



**Fig-2:** Correlations of LF nu and HF nu with duration of works per day in group B (n=30)



**Fig-3:** Correlations of LF/HF with duration of works per day in group B (n =30)

### Discussion

The present study was undertaken to observe the heart rate variability (HRV) in apparently healthy heavy workers in order to assess the role of regular physical activity on cardiac autonomic nerve function status. In this study, HRV parameters were measured like LF power and LF nu for sympathetic activity and total power, HF power and HF nu for parasympathetic activity

and also LF/HF ratio for sympatho-vagal balance. For this, age, sex and BMI matched healthy sedentary workers of low socioeconomic status were also studied for comparison (control).

In the present study, the finding of HRV parameters in healthy control group were almost similar to those reported by the various investigators from different countries<sup>13,25</sup>. Significantly higher total power, HF power and HF nu observed in this study are suggestive of higher cardiac autonomic nervous activities in the subjects of the reported series which are similar to the findings reported by other investigators<sup>9,16-18,20,24,28</sup>. This change may depend on duration of works per day. Positive relationships of total power and HF nu with duration of works per day also support the statement. This study also showed significantly lowered LF power and LF nu which are suggestive of lower sympathetic activity in heavy workers of present series. Similar effects were also reported by other investigators<sup>17,24,25</sup>. Negative correlation of LF nu with duration of works per day is also in favour of this finding. Shifting of sympatho-vagal balance of heavy workers of the present series towards parasympathetic dominance is also consistent with the findings of some investigators of different countries<sup>9,24</sup>.

Increase in cardiovagal baroreflex sensitivity, the acetylcholine content, choline-acetyl transferase activity in the cardiac tissue and the cardiac beta-receptors responsiveness may also be responsible for the changes in cardiac autonomic activity, but it is difficult to comment on these, as all the above mentioned parameters were not possible to measure in the subjects of the present series. Therefore, the exact mechanism involved with increase cardiac parasympathetic activity and decrease cardiac sympathetic activity due to physical activity cannot be revealed from this type of study. In the present study, nonsignificant difference of all HRV parameters between sedentary subjects of higher and lower socioeconomic condition are suggestive of less importance of nutritional status. However, to elucidate this factor further study with different nutritional parameters may be helpful.

From the above feature it is clear that heavy physical activity modulates cardiac autonomic nervous activity in the direction which is related to improved cardiac function. The physical activity may play an important role in the maintaining cardiovascular health and thereby preventing cardiac morbidity and mortality.

### Conclusion

Increased cardiac parasympathetic activity or decreased sympathetic activity with shift of cardio sympatho-vagal balance towards parasympathetic may occur in heavy workers in comparison to sedentary workers. Therefore,

this feature indicates that cardiac autonomic nerve activity is improved in subjects who undertake regular intensive physical activity. Thus regular physical activity is helpful to maintain normal sympatho-vagal balance as well as beneficial in preventing the occurrence of different types of cardio vascular diseases.

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