

## Effect on Time Domain Parameters of HRV after Slow Breathing Exercise in Type 2 Diabetes Mellitus

Jenefer Yesmin<sup>1</sup>, Noorzahan Begum<sup>2</sup>, Sultana Ferdousi<sup>3</sup>

### Abstract

**Background:** Cardiac autonomic nerve dysfunction has been associated with Type 2 Diabetes Mellitus (T2DM) with reduced Heart Rate Variability (HRV). Regular practice of slow breathing exercise (SBE) improves cardiac autonomic nerve function. **Objective:** To assess the effects of slow breathing exercise on cardiac autonomic nerve function by analysis of HRV in patients with Type 2 Diabetes Mellitus (T2DM). **Methods:** This prospective interventional study was carried out in the Department of Physiology, Bangabandhu Sheikh Mujib Medical University in 2015. For this, total 30 male diagnosed T2DM patients from the Out Patient Department of Endocrinology, BSMMU aged 45-55 years with diseases duration of 5-10 years were included in the study group. All the patients underwent slow breathing exercise (SBE -30 mins twice daily) for 3 months along with medical treatment. Mean heart rate (HR), mean R-R interval, standard deviation of the NN intervals (SDNN), Square root of mean squared differences of successive N-N intervals (RMSSD) of HRV parameters were recorded at the beginning of 3 months and also at the end of 3 months of study period. Thirty age, BMI matched healthy subject also included as control. For statistical analysis paired and unpaired sample t-test were done as applicable. **Results:** In this study, Pre-exercise value of mean HR was significantly higher ( $p < 0.001$ ) and Pre-exercise values of mean R-R interval, SDNN and RMSSD were significantly lower ( $p < 0.001$ ) in diabetic patients in comparison to control. After 3 months of performing SBE, post exercise values of all parameters were improved significantly ( $p < 0.001$ ). **Conclusion:** The results of this study revealed that SBE has some beneficial effects on cardiac autonomic balance in T2DM patients.

**Key words:** heart rate variability, type 2 diabetes mellitus, slow breathing exercise.

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### Introduction

**D**iabetes mellitus (DM) is a metabolic disorder characterized by hyperglycemia resulting from impairment of insulin secretion and/or insulin action<sup>1</sup>. It is a worldwide health problem that increases cardiovascular morbidity and autonomic neuropathy<sup>2-3</sup>. The parasympathetic nerve fibers

innervating the heart are affected earlier than the sympathetic nerve fibers during progression of cardiac autonomic neuropathy (CAN)<sup>4</sup>. Reduced heart rate variability (HRV) is the manifestation of CAN which results from damage to the autonomic nerve fibers innervating the heart and blood vessels<sup>5</sup>. Time domain method determines the heart rate at any point in time or the intervals between successive normal QRS complex in a

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continuous ECG record. Simple time domain indices comprise mean normal to normal QRS complex (NN) interval and mean HR, the difference between longest and shortest NN interval and maximum and minimum NN ratio.

Statistical time domain indices comprise standard deviation of the NN interval (SDNN), root of the mean squared differences of successive NN intervals (RMSSD), the number of interval differences of successive NN intervals greater than 50 ms (NN50), and pNN50, the proportion derived by dividing NN50 by the total number of NN intervals. Mean heart rate and mean R-R interval can be used to assess both sympathetic and parasympathetic nerve function activity. SDNN measured in time domain method that represents the total heart rate variability (both sympathetic and parasympathetic nervous system). RMSSD represents the vagal modulation<sup>6</sup>.

Yoga is an ancient technique that brings balance in physical health, mental health, emotional and spiritual dimensions<sup>7</sup>. Yoga practice is a form of stress reducing method in type 2 diabetic patients<sup>8</sup>. Many researchers reported about improvement of cardiac autonomic nerve function when the healthy subjects performed yoga based slow breathing exercise<sup>9-13</sup>.

Many researchers had also seen improvement in cardiac autonomic nerve function status in many diseased conditions like asthma, essential hypertension including type 2 Diabetes mellitus (T2DM) after practicing yoga based exercise<sup>14-18</sup>. On the contrary, some other group of investigators reported almost no significant change in cardiac autonomic balance after slow breathing exercise in healthy subject<sup>19</sup>.

On the basis of these findings this study was designed to see the effect of SBE on autonomic balance in patients with type 2 diabetes mellitus.

## Methods

This prospective interventional study was carried out in the department of Physiology,

Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka from March'15 to February'16. The protocol of this study was approved by Institutional Review Board of BSMMU. Thirty diagnosed male patients with type 2 diabetes mellitus aged 45-55 years with fasting blood glucose 5.9-8.9 mmol/l were recruited by simple random sampling from Endocrinology OPD, BSMMU. All patients were treated with oral anti-hyperglycemic drugs and lifestyle management (diet and exercise). After collecting baseline data study group (B) underwent slow breathing exercise (SBE) for 3 months. Thirty male healthy controls (A) with similar age and BMI were enrolled through personal contact. All the subjects were free from history of chronic illnesses such as renal and heart diseases, neurological, psychological and thyroid disorders and smoking. History of any kind of yoga practice was also ruled out.

The aim, benefit and procedure of the study were explained and informed written consent was obtained from all the study participants. A detailed family and medical histories were taken. A thorough clinical examination of all subjects was done and all information was recorded in a prefixed questionnaire.

The subjects were advised to take their meal by 9:00pm at previous night with sound sleep and avoid any physical or mental stress and sedative. They were also advised to take light breakfast without tea and coffee in the morning of examination.

All the examinations were done in the Autonomic Nerve Function Test Laboratory in the department of Physiology BSMMU. HRV recording was done by RMS Polyrite D machine. Before recording the subject was allowed to take rest for at least 5 minutes in calm and silent environment. Then minimum 5 minutes ECG recording was taken in supine position.

After recording HRV parameters, the steps of SBE were explained to them. Seven consecutive days training on SBE was given to them.

Alternate nostril breathing<sup>10</sup> as style of SBE was performed by the patients for three months.

Data were analyzed before and after SBE and then compare with control. For statistical analysis, paired and unpaired 't' test were done.

## Results

The pre-exercise values of pulse rate, systolic blood pressure and diastolic blood pressure were found significantly higher in diabetic patients compared to those of control (Table I).

**Table I:** General Characteristics in different groups (n=60)

Parameters	Control (n=30)	T2DM (baseline/pre-exercise value)
Age ( years)	48.5±0.50	49.86±0.56
BMI(sq/m)	22.89±0.23	23.24±0.23
SBP(mm ofHg)	125.33±1.04	129.14±1.41**
DBP(mm ofHg)	77±0.88	80.34±0.89*
Pulse Rate (beat/mint)	77.03±0.80	82.69± 0.84***

Data were expressed as Mean ± SE. (\*\*\*) = p<0.001, \*\* = p< 0.01 and \* = P < 0.05)

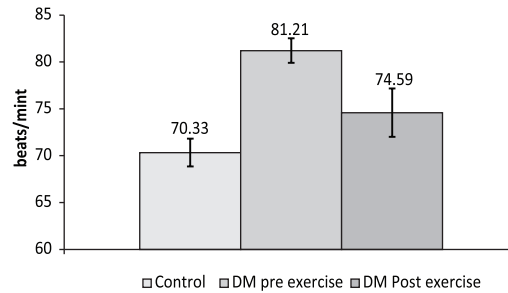
Pre-exercise mean value of mean HR was significantly (p<0.001) higher and pre-exercise values of mean R-R interval, SDNN, RMSSD were significantly (p<0.001) lower than those of control (Table II).

**Table II:** The values of Time Domain parameters in different group (n=60)

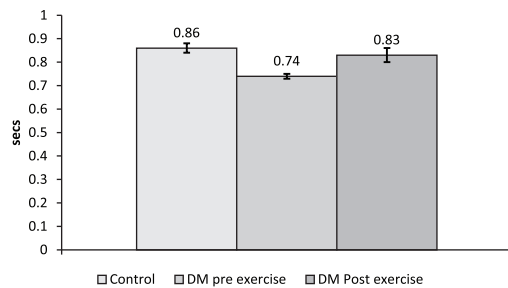
Parameters	Control	T2 Mpre- exercise	T2D Mpost exercise
Mean HR (beats/mint)	70.33± 1.48	81.21± 1.31*** δ	74.59± 2.59* Û
Mean R-R (sec)	0.86± 0.02	0.74 ± 0.01*** δ	0.83 ± 0.03* Û
SDNN (ms)	54.17± 3.14	28.11 ± 1.63*** δ	48.27 ± 5.22** Û
RMSSD (ms)	48.25± 2.48	15.50 ± 1.28*** δ	44.83 ± 6.71*** Û

Data were expressed as Mean ± SE. (\*\*\*) = p<0.001, \*\* = p< 0.01) T2DM=Type 2 Diabetes mellitus δ =Independent sample 't' test, Û = Paired sample 't' test.

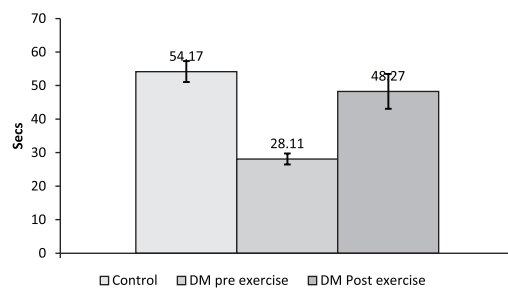
Post exercise mean values of all parameters improved significantly (p<0.001) after 3 months of slow breathing exercise in comparison to their pre-exercise value.



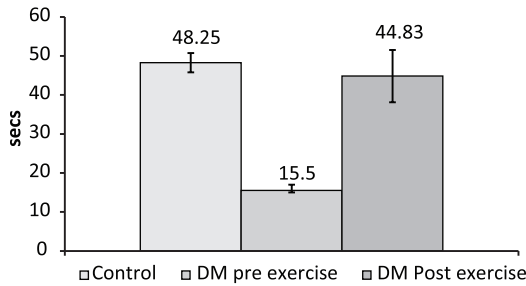
**Figure 1:** Mean HR in different groups. Post exercise HR was significantly improved in DM.



**Figure 2:** Mean RR in different groups. Post exercise RR was significantly improved in DM.



**Figure 3:** Mean SDNN in different groups. SBE significantly improved SDNN in DM.



**Figure 4:** Mean RMSSD in different groups. RMSSD was significantly improved after SBE in DM.

### Discussion

In this study, the baseline values of pulse rate, systolic blood pressure, diastolic blood pressure and mean HR were significantly higher in diabetic patients in comparison to control. Slow breathing exercise for 3 months reversed all these values towards parasympathetic predominance.

Higher values of pulse rate, systolic blood pressure, diastolic blood pressure, mean HR and lower values of mean R-R interval, SDNN, RMSSD in diabetic patients indicate autonomic imbalance towards sympathetic predominance<sup>3-4, 20-21</sup>.

The significant decrease of post exercise value of mean HR was observed in this study. But some researchers found no significant change after breathing exercise in both healthy subjects and diseased condition<sup>12, 15, 22-23</sup>.

The significant increase of post exercise value of mean R-R interval, SDNN, RMSSD was observed in this study which is consistent with findings of other researchers in healthy subjects after practicing yoga<sup>23, 24</sup>. But some researchers reported about no significant change after breathing exercise in both healthy subjects and diseased condition<sup>12, 15, 19, 25</sup>.

From this study it is obvious that slow breathing exercise improved cardiac autonomic nerve function towards parasympathetic predominance in this group of patients which was indicated by significant change of post exercise value of mean

HR, mean R-R interval and RMSSD in comparison to pre-exercise value.

Slow deep breathing exercise shifts the attention of the subject from the surrounding and increase concentration towards the breathing which relieves the subject from stress. This stress free condition might decrease sympathetic activity and thus decrease heart rate<sup>10, 26</sup>. Thus SBE might shift autonomic nerve function activity away from sympathetic dominance.

Yoga based slow breathing exercise might increase vagal tone which shift sympathovagal balance towards parasympathetic predominance<sup>9, 12-14, 17-18, 27</sup>. Moreover SBE might also increase baroreflex sensitivity<sup>28, 29</sup>.

It has been also suggested that synchronization of neural tissue including hypothalamus and brainstem due to generation of hyperpolarization current in fibroblast of lungs, decrement of adrenaline may be responsible for the changes in this study<sup>28-31</sup>.

### Conclusion

From this study, it can be concluded that autonomic nerve dysfunction with sympathetic predominance occurred in T2DM and yoga based SBE could improve autonomic activity towards parasympathetic dominance.

**Conflict of interest:** None

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