

## Pattern of Heart Rate Variability in Somatoform Disorder and Its Association with Anxiety level: An Analytical Study

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### Abstract

**Background:** Somatoform disorder (SD), nowadays considered as the most frequent psychiatric diagnosis in general practice has strong association with anxiety. Though there are a handful of studies showing heart Rate variability (HRV) in SD patients, as such no studies according to author's knowledge had been addressed to the anxiety component hidden in the SD patients applying HRV tests so far.

**Aims:** Aim of the current study was assess the presence and extent of Heart rate variability in SD patients and to find out it's possible relationship with their anxiety level.

**Materials and Methods:** An analytical observational cross-sectional study was done among fifty newly diagnosed somatoform disorder patients of eighteen to forty years age attending Psychiatry OPD and fifty age and sex matched healthy control. After assessing their anxiety level using State Trait Anxiety Inventory, Short term Heart rate Variability tests were performed. Appropriate Statistical tests were applied using SPSS 20 version.

**Results:** The SD patients showed reduced heart rate variability as SDNN and RMSDD were less, LF and LF/HF ratio were more in them than controls and significant differences were there. Both SAS and TAS scores were more in cases and there was positive correlation of TAS score with LF and LF/HF ratios.

**Conclusions:** The results of this study actually set an alarm for controlling their symptoms as well as their hidden anxiety underneath, as reduced HRV poses the risk of developing cardiovascular disease and hidden anxiety has influence on heart rate variability.

**Keywords:** Somatoform disorder, Heart Rate variability. Anxiety level, Sympathetic and parasympathetic functions.

### Introduction

Somatization is a ubiquitous human

phenomenon that at times becomes problematic and warrants clinical attention and it is extremely common in medical settings.<sup>1</sup> Sometimes somatic

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symptoms are expression of an identifiable emotional disorder.<sup>2</sup> The term somatization has been used to describe the tendency of certain patients to experience and communicate psychological and interpersonal problems in the form of somatic distress and medically unexplained symptoms for which they seek medical help.<sup>3</sup> ICD 10 description of somatoform disorders emphasized on repeated presentation of physical symptoms, together with persistent requests for medical investigations, in spite of repeated negative findings and reassurances by doctors that symptoms have no physical basis.<sup>4</sup> DSM 5 has constituted a new category named somatic symptoms and related disorder replacing previous somatoform disorders which includes the diagnosis of somatic symptom disorders, illness anxiety disorder, conversion disorder etc.<sup>5</sup> The interaction between “psyche and “soma” are well known. This interaction happens through a complex network of feed-back and modulation among the central and autonomic nervous system (ANS), the endocrine system, immune system and the stress system.<sup>6</sup> A model by Brown (2004) addressed on this issue by showing how physical symptoms can arise and the autonomic control of action is over determined by typical presentation of illness.<sup>7</sup> Clinical symptoms of these disturbances are frequently non-characteristic<sup>8</sup> Different studies had indicated that autonomic arousal increases the likelihood of misinterpretation of bodily signals.<sup>9</sup>

So far very few works have been undertaken to find the influence of autonomic nervous system in developing, maintaining and determining the course of somatoform illness. There are many tests to assess cardiovascular autonomic function and measurement of heart rate variability (HRV) is a useful non-invasive tool among those. The heart rate variability denotes variations in instantaneous heart rate as well as RR intervals in consecutive cycles. Increased vagal activity decreases heart rate and produces heart rate variability, but increased sympathetic activity has opposite effect. So, heart rate and its fluctuation according to need indicate autonomic control over cardiovascular system. A long term measure of HRV parameters gives the idea about the challenges faced by cardiac autonomic functions in daily life. As recordings are not stationary in this situation, so standardisation cannot be maintained. Short term HRV analysis solves this limitation as it can be performed and interpreted from 5 min ECG recording maintaining standard criteria excluding the exogenic influence on cardiovascular autonomic tone.<sup>10</sup>

There are studies involving heart rate variability tests in somatoform disorder patients and most of them revealed altered HRV in somatoform disorder patients. Still how autonomic dysfunction contributes to the pathophysiology of somatoform disorder is not clearly understood. A study in Seoul had shown correlation of HRV with alexithymia in somatoform disorder patients.<sup>9</sup> Another study showed negative correlation between alexithymia and HRV.<sup>11</sup> Alexithymia is deficit in cognitive processing of emotional information. Different studies have shown that somatoform disorder has strong association with pathological personality traits as well as anxiety and depression. Not only that a study also showed that Anxiety has a greater effect on emotional feeling of somatoform disorder patients than depression.<sup>12</sup>

As such no studies according to author's knowledge had been addressed to the anxiety component hidden in the somatoform disorder patients applying HRV tests so far. The current study intends to explore this hidden component in somatoform disorder patients.

So, the research hypothesis is the presence of reduced heart rate variability among somatoform disorder patients and those measures of HRV are associated with higher anxiety level.

## Materials and Methods

**Study type, design and population:** An analytical observational cross-sectional study was done in one year in Autonomic function Laboratory of Department Physiology of a Govt. Medical College and Hospital. We had selected study group from newly diagnosed somatoform disorder patients of eighteen to forty years age group attending Psychiatry OPD according to ICD 10 and age and sex matched control subjects were selected from accompanying persons of those patients without having any psychiatric comorbidities in 1: 1 ratio (case: control).<sup>4</sup>

**Sample size and sampling design:** To select study subjects, one day per week was selected randomly using computer program during the study period. On that day, all persons with diagnosis of new case of somatoform disorder were approached for participation in the study. The sample size was fifty maintaining inclusion and exclusion criteria. An equal number of age and sex matched control without any psychiatric comorbidities were selected from the

accompanying persons of the said patients who were voluntarily willing to participate and general health questionnaire (GHQ-28) was used for screening of those subjects.<sup>13</sup>

**Exclusion criteria:** (applied in selecting both case and control groups) - Individual having Cardiac disease, Hypertension, Diabetes mellitus, Neurological disease, Retinopathy, Nephropathy, Autoimmune diseases, any other acute or chronic systemic disease(s) or associated factor(s) that may affect the autonomic reflexes and individual who did not give consent.

**Method of data collection:** The study was commenced after getting Institutional ethical clearance. The cases were selected by psychiatrists after having clinical and general examination of the patients. After maintaining the inclusion and exclusion criteria written informed consent was taken from each individual participating in the present study. A pre-test instruction was given to avoid consumption of any medicines that may alter the autonomic function 48 hours prior to the test. The subject was advised to have a sound sleep without using elasticized or tight garments at the previous night. On the day of the test, no cigarette, nicotine, coffee, food or medicines orally or other routes was permitted for two hours prior to the test.<sup>14</sup> The subjects were asked to wear loose gowns, and tight under clothing, metallic objects like rings, watches etc. On the day of the tests State - Trait Anxiety Inventory (STAI) was applied among the study subjects.<sup>15</sup>

Short term (5 min) heart rate variability (HRV) tests were performed with the help of Polyrite-D machine in the Autonomic research laboratory room. Polyrite-D, an electrical device with multi-channel physiograph recording with in-built electrocardiograph (ECG) channel was used for recording electrocardiogram, and the machine has its inbuilt system for analysis of RR intervals. Lead II of the ECG was selected for recording heart rate. Calibration was undertaken before the start of recording heart rate and maintained throughout the procedure. Tracing speed used was 30 mm/sec. ECG tracing was recorded in supine position by conventional method during normal quiet breathing for a period of five minutes. The ECG tracings were screened for any suspected pathological waveform configuration.

HRV analysis was done by using time domain or frequency domain analysis. For time domain analysis of short term HRV, among different parameters SDNN and RMSDD values are preferred. SDNN is the standard deviations of the RR intervals of the recording and represents the overall HRV. RMSDD is the square root of the mean of sum of the squares of differences between adjacent RR intervals and pNN50 is the percentage of number of pairs of adjacent RR interval differing by more than 50 ms. Both reflect high frequency variations of heart rate indicating parasympathetic effect on heart, but RMSDD is preferred and most commonly used measure. In frequency domain analysis of short term HRV, HF (0.15 - 0.4 Hz), LF (0.04 - 0.15 Hz), LF/HF ratio can be calculated. Normalized units of HF and LF component indicate parasympathetic and sympathetic tone of cardiovascular activity respectively and LF/HF ratio, a marker of sympatho-vagal imbalance. The physiological explanation of VLF (<0.04) is not known properly. But it is important that measures of HRV irrespective of time domain or frequency domain measures do not represent the exact level of autonomic nerves activity but their combination indicates an alteration and interaction of sympathetic and parasympathetic nerve activity.<sup>10</sup> In this study we used SDNN, RMSDD and pNN50 for time domain analysis and LF, HF, LF/HF ratio for frequency domain analysis.

#### **Statistical analysis:**

All the collected data were at first entered a Microsoft Excel spreadsheet and data cleaning/filtration were done. Further analysis was conducted with the help of IBM SPSS (Software Package for Social Sciences) Statistics Version 20.0. Descriptive information was calculated in frequencies, percentages. For describing the central tendencies and dispersions of various observations Mean & SD (Standard Deviation) were calculated. For comparing mean values of various parameters between case & control groups, unpaired t test was applied to find out statistical significance. Likewise for finding correlation of two independent groups Pearson correlation test was applied. Test results were considered statistically significant at p value < 0.05.

## Results

**Table 1: Distribution of study subjects according to their Resting Heart Rate (RHR)**

Resting HR of Cases		Resting HR Control	
Male (mean + SD)	Female (mean + SD)	Male (mean + SD)	Female (mean + SD)
81.10 + 6.60	84.47 + 11.62	74.29 + 8.01	71.63 + 6.60

Table 1 of this study shows that mean resting heart rate was found more in male (81.10 + 6.60) and female (84.47 + 11.62) somatoform disorder patients

than their control counterpart (male 74.29 + 8.01 and female 71.63 + 6.60) and a significant difference ( $p = 0.006$ ) was there between case and control subjects.

**Table 2: Distribution of study subjects according to their Resting Blood Pressure**

Resting BP of Cases		Resting BP of Control	
SBP (mean $\pm$ SD)	DBP (mean $\pm$ SD)	SBP (mean $\pm$ SD)	DBP (mean $\pm$ SD)
118.12 $\pm$ 11.28	77.0 $\pm$ 7.15	117.28 $\pm$ 10.32	78.88 $\pm$ 4.80

In table 2 mean systolic blood pressure was more and diastolic blood pressure was less in somatoform

disorder patients, but no significant difference was found.

**Table 3: Comparison of mean score of different study variables between cases and controls**

Variables	t-test for Equality of Means				
	t	df	p	Mean $\pm$ SD	Mean $\pm$ SD
SAS	2.108	81	.038	38.49 $\pm$ 11.614	33.18 $\pm$ 10.805
TAS	3.173	81	0.002	43.22 $\pm$ 10.695	35.56 $\pm$ 11.007
SDNN	-3.970*	36.609	.000	31.60 $\pm$ 14.279	65.02 $\pm$ 46.720
RMSDD	-3.213*	46.472	.002	23.31 $\pm$ 15.972	41.444 $\pm$ 29.245
PNN50	-1.877*	58.694	.066	8.625 $\pm$ 13.851	15.693 $\pm$ 17.912
LF nu	3.998	82	.000	65.696 $\pm$ 43.470	34.376 $\pm$ 16.752
HF nu	-8.505*	76.207	.000	34.519 $\pm$ 24.421	77.716 $\pm$ 21.716
LF/HF	5.641	82	.000	2.348 $\pm$ 1.912	0.479 $\pm$ 0.292

\*Equality of variances not assumed

**Table 3** shows that both State anxiety score (SAS) and Trait anxiety score (TAS) were more in somatoform disorder patients [SAS case (38.49  $\pm$  11.614) and control (33.18  $\pm$  10.805)] and [TAS case (43.22  $\pm$  10.695) and control (35.56  $\pm$  11.007)] and both the groups were significantly different (SAS  $p=0.038$ ) and (TAS  $p=0.002$ ).

While comparing different HRV parameters in table 3, it was found that SDNN was less in somatoform disorder patients (31.60  $\pm$  14.279) than control subjects (65.02  $\pm$  46.720) and a significant difference ( $p=0.000$ ) was there between the two.

RMSDD was less in case (23.31  $\pm$  15.972) than control (41.444  $\pm$  29.245) and was also significantly different (0.002). pNN50 was also less in somatoform disorder patients than control and it was not statistically significant. In frequency domain analysis of HRV, LF was more in somatoform disorder patients (65.696  $\pm$  43.470) than control subjects (34.376  $\pm$  16.752) and a significant difference (0.000) existed between the two. The case had less HF values (34.519  $\pm$  24.421) than their healthy counterpart (77.716  $\pm$  21.716). LF/HF ratio was more in somatoform disorder patients than Controls) and it was also significantly different (0.000).

**Table 4: Correlation between dependent and independent variables**

		SDNN	RMSDD	PNN50	LF	HF	LF/HF
SAS	Pearson Correlation	-.174	-.108	-.106	.093	-.120	.098
	Sig. (2-tailed) (p)	.135	.355	.365	.402	.280	.379
TAS	Pearson Correlation	-.200	-.025	.017	0.246	-.164	0.223
	Sig. (2-tailed) p)	.086	.833	.884	0.025	.138	0.42

In table 4 while assessing correlation between different components of HRV parameters with SAS and TAS score as dependent variable, it was found that there was positive correlation in LF (0.246) and LF/HF ratio (0.223) with TAS score ie. High trait anxiety score is associated with high LF and LF/HF ratios and both of these are significant ie for LF ( $p=0.25$ ) and LF/HF ratio ( $p=0.42$ ). High SAS and TAS score were associated with low HF in frequency domain and low SDNN, pNN50, RMSDD in time domain, though they were not statistically significant ( $p>0.05$ ).

### Discussion

An analytical observational study was conducted among fifty newly diagnosed case of somatoform disorder and fifty age and sex matched healthy adults as controls to assess and compare the heart rate variability. Anxiety status of the subjects was also assessed and different parameters of heart rate variability were correlated with the anxiety level of the patient.

In this study the somatoform disorder patients showed reduced heart rate variability and there was positive correlation of LF values and LF/HF with trait anxiety score.

The study subjects consisted of different age groups ranging from 18 – 40 years with the mean age  $29.04 \pm 6.8$  years and no significant difference ( $p > 0.05$ ) existed between case and control groups regarding age distribution, to conclude that both the groups were age and sex matched. A study conducted by Deka K et al showed that 57.5% were in the 18-29 years age range.<sup>16</sup> However a few studies like that of Deveci A. et al in Turkey, showed the peak incidence in the mid to late thirtys.<sup>17</sup> According to DSM 5 Somatic symptom disorder may be underdiagnosed in older adults either because some symptoms are considered part of normal aging.<sup>5</sup>

While assessing anxiety level SAS and TAS was more in somatoform disorder patients than control subjects. Banks MH et al in 1975 also showed that patients without having significant illness and consistently seeking medical care have high trait anxiety score.<sup>18</sup> A case control studies conducted showed that higher prevalence of anxiety was present in somatoform disorder patients than control and it was clinically significant (odds ratio in the range of 2.3 – 3.5).<sup>19,20</sup>

Both parasympathetic and sympathetic nervous system control heart rate, blood pressure and maintain the balance. Resting heart rate can be used to assess both SNS and PNS reactivity. In the present study, mean resting heart rate was higher in both male and female than control. This higher resting heart rate may be due to associated anxiety in the somatoform disorder patients and also have reduced PNS activity. It has been seen that most cases of somatoform disorder are also associated with anxiety and depression.<sup>21</sup> Resting systolic and diastolic blood pressure was in the normal range. This may presumably because of multiple blood pressure regulatory systems running in parallel and autonomic disturbances might have been counterbalanced by other regulatory mechanisms.

In this study among different parameters of HRV, Somatoform disorder patients had lower SDNN, RMSDD values. SDNN reflects the overall lower HRV and RMSDD, the reduced PNS activity. LF value, LF/HF ratio was more and HF was less in somatoform disorder patients than control with statistically significant differences between two groups. These indicate sympatho-vagal imbalance with high LF and low HF measures in somatoform disorder patients. So, our study has shown reduced HRV with high SNS, low PNS activity indicating sympatho-vagal imbalance. Somatoform disorder patients had reduced parasympathetic activity which may be explained by the presence of comorbid

anxiety in these patients.<sup>22</sup> Low SDNN was found in somatoform disorder patients while performing some tasks in another study.<sup>23</sup> In a study by Zimmermann V et al (2016), using HRV in different psychological disorder like somatoform disorders, adjustment disorders, major depression, anxiety disorders, a shift of autonomic balance towards sympathetic predominance was found.<sup>24</sup> A study in Seoul supports our study finding by showing low SDNN, RMSDD, HF and high LF, LF/HF ratio values in somatic symptom disorder patients.<sup>9</sup> However, a study by Chaudhary K. et al (2016) showed a negative correlation of LF/HF ratio with somatization of stress, which should have been positive.<sup>25</sup> This may indicate that subjective and objective measures may not always show direct relationship to each other. It has been suggested that RMSDD, HF parameter of HRV indicating PNS activity is related to the activities in cingulate, prefrontal cortex and patients with somatoform disorder also develop significant changes in functional interconnection among prefrontal, cingulate cortex, insula.<sup>9</sup> From this we can say that somatoform disorder patients in our study have low HRV parameters mediated by decreased PNS activity.

While performing correlation test, positive correlation was found between LF and LF/HF parameters with trait anxiety score of somatoform disorder patients in present study. In a study among anxiety disorder patients by Yeragani VK et al, symapatho-vagal imbalance showing sympathetic predominance was found.<sup>26,27</sup> Watkins LL et al found an association between trait anxiety score and parasympathetic activity in adults with anxiety disorder patients.<sup>28</sup> Recently a study has shown that levels of anxiety have no effect on HRV parameters in somatic symptom disorder patients.<sup>9</sup> However, in a study conducted among children and adolescents with generalized anxiety disorder at All India Institute of Medical Sciences by Sharma RK et al, no correlation was found between state and trait anxiety scores and the autonomic function parameters.<sup>29</sup> A study had shown specific interactions among higher trait anxiety, abnormalities of sympathetic activity, and endothelial dysfunction, which may clarify the association of anxiety with increased risks for atherosclerosis and cardiovascular disease.<sup>30</sup> Till date, there is practically a handful of studies to

find out the effect of anxiety in somatoform disorder patients on their HRV parameters. So, in support of the current study finding it can be said that emotions involve a mix of cortical (e.g., frontal, temporal and parietal) and subcortical/limbic (e.g., basal ganglia, thalamus, amygdala and hippocampus) regions of the brain and there is a relationship between emotions and changes in the ANS. Porge's Polyvagal Theory suggests that the vagus nerve connects to various brain regions and serves as a brake or modulator. Conditions of extreme stress break down this highly sensitive means for stabilizing the human organism causing decreased parasympathetic activity in somatoform disorder patients.<sup>31</sup> In response to fear, exercise and other types of stress, the sympathetic division produces a massive and coordinated output to all end organs simultaneously and parasympathetic output ceases.<sup>32</sup>

So, to summarize this study revealed somatoform disorder patients had symapatho-vagal imbalance resulting in reduced heart rate variability and that might be influenced by their trait anxiety underneath.

## Conclusion

This study showed that somatoform disorder patients had reduced heart rate variability. Their anxiety level was more and that might influence their HRV parameters. This fact actually sets an alarm for controlling their symptoms as well as their hidden anxiety underneath. Different studies had shown that reduced heart rate variability poses the risk of developing cardiovascular disease. As hidden anxiety has influence on heart rate variability, so effort should be there to treat their anxiety component along with their symptoms.

## Limitations

Study was conducted in a small sample and was of cross-sectional type. Longitudinal study involving large sample may give better result.

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