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Original Article

A Comparative Cross-Sectional Study of Cardiac Autonomic Status by Five Minute Heart Rate Variability among Type 2 Diabetics, Hypertensives and Normotensive-Nondiabetics

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Abstract

Background: Diabetes and hypertension are known to co-exist frequently as adverse cardiovascular risk factors. Both can produce cardiac autonomic neuropathy that can be measured by ECG RR interval-based heart rate variability (HRV). We compared 5 minutes HRV in four groups based on diabetes and hypertension.

Methodology: A cross sectional study was done on 203 participants divided into four groups- diabetics, hypertensives, diabetic-hypertensives and normotensive-nondiabetics. They were evaluated for current disease control and five minutes HRV was done in supine condition following standard protocols by Variowin HR Software. HRV parameters of time domain, frequency domain and Poincare plot were compared between groups and associated with gender, glycaemic control and blood pressure control. Statistical significance was set at $p<0.05$.

Results: Three diseased groups had mean age in mid-fifties, mean duration of disease > 6 years, comparable BMI, poor glycaemic and blood pressure control. As compared to normal groups, three diseased groups exhibit reduced HRV with respect to all three domains of HRV with varying statistical significance. Among diseased groups, HRV was associated with blood pressure control better than glycaemic control but not with gender. LF /HF ratio was the most consistent HRV parameter showing statistical significance in tests. **Conclusion:** HRV is reduced in both diabetics more than hypertensives; related to blood pressure control more than glycaemic control. It points altered cardiac autonomic balance, and possibility of cardiovascular risk and early detection of it with timely intervention. It also calls for investigation of same for reinforcement of our observations and further exploration.

Keywords: Autonomic Neuropathy; Blood Pressure; Cardiac; Glycaemic; Hypertension; Type 2 Diabetes.

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Quick Response Code:

Introduction

Type 2 Diabetes mellitus (DM) is reaching its ever-high surge and there is an alarming rise in hypertension (HTN) in India [1] with felt need to effectively fight against both. DM and HTN frequently occur concurrently and have synergistic detrimental effects on the cardiovascular system.[2] Cardiac autonomic neuropathy is dreadful but neglected complication of both these conditions and this can be measured by heart rate variability (HRV) which is actually variability of ECG RR interval.[3] A healthy heart is not a metronome and physiological HRV is a sign of healthy heart.[4] HRV can be further analysed by time domain, frequency domain and non-linear methods.[4] HTN[5] and DM[6] are two most common causes of reduced HRV. Both have a threatening synergistic effect with sub-optimal disease control in majority patients and same is evident in diabetics or hypertensives in our region as per previous study. [7, 8] Most studies have taken either of these two, but it would be interesting if HRV is compared in four groups based on presence or absence of HTN and/or DM. This study aimed to compare 5 minutes HRV between diabetics, hypertensives, diabetic-hypertensives and normotensive-nondiabetics for comparison.

Methodology

Study design: The present study was a community based cross sectional study done on 203 participates under guidance of Physiology department of our college. Permissions of department of Physiology and Medicine of our college were taken, and it was followed by approval of Institutional Review Board of our college. Permissions from the physicians and written consent from all study participants were taken and they were informed about the benefits and aim of this study.

Study Groups: We enrolled 4 study groups by stratified random sampling as below.

Group	Risk factor	Participants	Abbreviation	Number
A	0	Normotensive nondiabetics	NTND	50
B	1	Normotensive diabetics	NTD	50
C	1	Hypertensive nondiabetics	HTND	50
D	2	Hypertensive diabetics	HTD	53

For group A, B and C, study participants were recruited as under treatment hypertensives and/or type 2 diabetics with known blood pressure and glycemic control attending private clinics or medicine OPDs of the tertiary care hospital affiliated to our college by stratified randomization.

For group D, non-hypertensive non-diabetic apparently healthy study participants were randomly selected from community and general OPDs.

Study participants

Inclusion criteria: Patients of both sexes, with hypertension and/ or diabetes (treated for at least 4 weeks), ready for giving written informed consent, regularly taking treatment (as per case record history), recent glycemic report known (of last 1 month) were included.

Exclusion criteria: Patients who were newly diagnosed, having neuropathy & vasculopathy due to other diseases, having previous neurological or cardio-vascular intervention, using cardiac pacemakers, consuming alcohol, smoking currently were excluded. Two participants were excluded after HRV measurement owing to irregular ECG pattern. After general data collection and medical history evaluation, neuropathy risk factor assessment was done by questionnaires. Initial assessment was done in the form of personal details, disease history, drug history, personal history, blood pressure measurement, laboratory investigations.

Measurements: [as per previous study][7]

Sitting blood pressure was measured with a random-zero mercury sphygmomanometer after a 5-min rest. Hypertension was defined as self-reported use of medications for high blood pressure during the 2 weeks

preceding the clinic examination. For all study participants glycaemic control was measured by fasting plasma glucose (FPG) and DM was defined as per America Diabetes Association Guidelines 2014. Subjects also brought to the examination all medications they had been taking. Apparently healthy participants under blood pressure cut off and under glycaemic cut off were taken in group D.

Assessment of HRV was carried out between 8.30 am and 12.00 noon in a separate examination room. Participants should not make movements while the test is going on and should not use cell phones near the unit when the test is going on. We recorded electrocardiogram for the analysis of beat-to-beat HRV after supine rest for at least 5 min, the subject being in supine position and breathing freely. Window-based software VarioWin HR (HRV Analysis system, Genesis Medical System Pvt. Limited, Hyderabad, Telangana, India) was used. Recorded ECG was transferred online to a microcomputer for the analysis of HRV. Only stationary time series of approximately 5-min durations free of arrhythmia and artifacts were used. The time domain, frequency domain variables, and nonlinear parameters were measured and taken for comparison.

Parameters Measured: The parameters measured were based on a previous study [7] and included the following time domain analysis parameters defined accordingly **SDNN (ms):** Standard deviation of all NN intervals; **SDANN (ms):** Standard deviation of the averages of NN intervals in all 5-minute segments of the entire recording; **RMSSD ms:** The square root of the mean of the sum of the squares of differences between adjacent NN intervals; **SDNN index ms:** Mean of the standard deviations of all NN intervals for all 5-minute segments of the entire recording, **SDSD ms:** Standard deviation of differences between adjacent N-N intervals; **NN50 count:** Number of pairs of adjacent NN intervals differing by more than 50 ms in the entire recording; and **Pnn50:** NN50 count divided by the total number of all NN intervals.

The Frequency domain analysis parameters were **HF:** high frequency - 0.15-0.4 Hz; **LF:** low frequency - 0.04-0.15 Hz; **ULF:** ultra-low frequency <0.003 Hz; **VLF:** very low frequency - 0.003-0.04Hz; **TP:** Total power - 0.0-0.4 Hz; **LF norm :** LF/(total power-VLF)x100 : 54+ 4; **HF norm :** HF/(total power-VLF)x100 : 29 + 3; and **LF/HF ratio -** 1.5 - 2.

The Non-linear Poincare plot analysis parameters were the **SD1:** Standard deviation of beat-to-beat instantaneous R-R interval variability; **SD2:** Standard deviation of the long term beat to beat R-R interval variability and **Scatter index:** SD1 to SD2 ratio

Statistical analysis

Data was entered in and sorted by Microsoft Office Excel 2007 and results were analyzed using GraphPad InStat 3.0 statistical software (demo version free software of GraphPad Software, Inc. California, USA). The mean, standard deviation and frequencies of the variables were expressed, and normality test was run prior to applying statistical test for each data. The student's unpaired t-test, Mann Whitney test and ANNOVA test were used for numerical data analysis and for categorical data; Chi Square test and Normality test were used. Differences were regarded statistically significant with the p value less than 0.05.

Results

The Mean age was in mid-50s in diseased groups (NTD, HTND, HTD) than control group (NTND) which was significantly younger. Gender distribution and BMI were comparable in all four groups. In diseased groups, blood pressure control was moderate and glycemic control was poor. [Table 1].

We compared time domain, frequency domain, frequency domain and geometric domain parameters of HRV in four study groups. In general, there was a significant reduction in all parameters of HRV in diseased groups than controlled group. Least HRV was in non-diabetic hypertensives followed by HTD and NTD. LF to HF ratio was higher in NTD and HTND group and within normal range (1.5-2) in HTND and HTD groups. [Table 2].

On comparing HRV based on gender, females had slightly reduced HRV than male, but results were significant only for LF-HF ratio. Females had better LF-HF ratio (1.69) than males (2.56). [Table 3]. HRV was compared among diabetics (NTD and HTD) stratified by glycaemic control. Good glycaemics had better HRV than poor glycaemics but results were significant only for VLF power, mode, NN50, and SD2. LF-HF ratio was better in good glycaemics than poor glycaemics. (1.62 v/s 2.47) [Table 4]. HRV was compared in diseased sub-groups stratified by current blood pressure control. Participants with blood pressure control had significantly better HRV than those with blood pressure uncontrolled. LF-HF ratio was normal in participants with blood pressure controlled than blood pressure uncontrolled subjects (1.43 v/s 2.23). [Table 5].

Table 1: Baseline data of study groups

	NTND group (n=50)	**NTD group (n=50)**	**HTND group (n=50)**	**HTD group (n=53)**	**Total**
General features	**Mean±SD-**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**P value**
Age(years)	48.12±10.30	57.26±10.77	54.68±9.35	56.05±8.35	**<0.0001***
Male/female	13/37	26/24	11/39	19/34	**0.0076***
Duration of DM/HTN (years)	_	7.5±1.6	6.2±2.1	8.9±3.3	-
Height (cm	158.94±10.11	162.68±7.835	161.46±8.45	160.88±8.038	0.2987
Weight(kg)	64.86±11.39	66.82±9.86	68.06±8.83	66.01±10.97	0.3106
BMI (kg/m^2)	25.76±4.42	25.49±3.80	26.47±3.91	25.57±4.33	0.6263
SBP (mm of Hg)	128.22±19.2	136.22±29.3	144.24±32.86	148.52±58.36	-
DBP(mm of Hg)	84.83±16.51	88.4±19.68	98.83±16.21	99.83±10.11	-
Glycemic control –prevalence	**Number (%)** 50/50 (100%)	**Number (%)** 15/50(30%)	**Number (%)** 50/50 (100%)	**Number (%)** 13/50 (26%)	**-** -
BP control-prevalence	**Number (%)** 50/50 (100%)	**Number (%)** 45/50 (90%)	**Number (%)** 17/53(32%)	**Number (%)** 25/50 (50%)	**-** -

Table 2: Quantitative comparison of HRV parameters between four groups (mean±SD)

HRV parameter	**NTND group (n=50)**	**NTD group (n=50)**	**HTND group (n=50)**	**HTD group (n=53)**	**P value**
VLF power	1011.72 ± 771.61	457.86 ± 522.10	687.44 ± 894.15	570.69 ± 658.42	**0.0012***
LF power	1360.54 ± 1926.1	411.65 ± 626.08	528.25 ± 816.59	355.76 ± 446.54	**<0.0001***
HF power	1041.44 ± 1369.4	762.47 ± 1970.30	671.85 ± 1234.9	486.42 ± 846.50	0.25
LF (nu)	0.57 ± 0.16	0.58 ± 0.23	0.84 ± 0.22	0.55 ± 0.18	0.60
HF (nu)	0.43 ± 0.15	0.41 ± 0.23	0.46 ± 0.22	0.44 ± 0.18	0.68
Maximum LF	0.10 ± 0.10	0.20 ± 0.98	0.07 ± 0.03	0.07 ± 0.03	0.49
Maximum HF	0.24 ± 0.11	0.28 ± 0.10	0.26 ± 0.08	0.28 ± 0.08	0.15
LF/HF ratio	1.76 ± 1.54	2.47 ± 2.13	1.69 ± 1.60	2.03 ± 3.67	0.37
Mode value	716.66 ± 110.74	666.18 ± 177.51	739.42 ± 207.87	697.10 ± 172.38	0.21
Triangular HRV index	8.16 ± 4.22	5.16 ± 2.84	8.24 ± 9.17	5.52 ± 2.54	**0.0042***
SDNN	41.37 ± 18.38	31.24 ± 37.63	32.74 ± 18.32	37.10 ± 52.13	0.47
RMSSD	37.15 ± 27.44	35.92 ± 66.61	29.22 ± 22.07	27.41 ± 23.66	0.64
SDSD	34.10 ± 25.75	30.60 ± 58.33	27.79 ± 22.79	25.25 ± 24.99	
NN50 count	39.36 ± 42.41	28.08 ± 61.11	20.42 ± 30.98	17.02 ± 34.45	0.05
PNN50%	12.63 ± 15.38	11.65 ± 29.99	9.18 ± 14.24	6.54 ± 12.55	0.38
R-R interval	738.72 ± 79.54	665.90 ± 153.28	736.19 ± 216.08	705.81 ± 162.54	0.09
SD1	26.28 ± 23.85	21.37 ± 32.02	21.75 ± 19.79	19.81 ± 19.06	0.70
SD2	45.21 ± 20.04	27.88 ± 21.94	32.70 ± 18.39	29.25 ± 15.07	**0.0005***
Scatter index	0.53 ± 0.31	0.65 ± 0.42	0.60 ± 0.35	0.60 ± 0.35	0.09

Table 3: Quantitative comparison of HRV parameters between male and females (of all four study groups) (mean±SD)

HRV parameter	Males (n=69) (mean±SD)	Females (n=134) (mean±SD)	P value
VLF power	639.65 ± 740.79	701.02 ± 753.11	0.58
LF power	689.70 ± 1392.20	643.95 ± 1046.05	0.79
HF power	833.06 ± 1768.40	687.22 ± 1191.07	0.49
LF (nu)	0.58 ± 0.23	0.55 ± 0.18	0.34
HF (nu)	0.43 ± 0.23	0.45 ± 0.18	0.50
Maximum LF	0.18 ± 0.06	0.08 ± 0.06	**<0.0001***
Maximum HF	0.27 ± 0.10	0.27 ± 0.09	0.97
LF/HF ratio	2.56 ± 3.54	1.69 ± 1.49	**0.0141***
Mode value	693.28 ± 173.34	710.01 ± 175.03	0.54
Triangular HRV index	5.83 ± 3.67	7.11 ± 6.24	0.13
SDNN	36.93 ± 40.90	32.93 ± 31.69	0.70
RMSSD	36.33 ± 58.42	30.25 ± 24.04	0.30
SDSD	31.92 ± 51.85	28.03 ± 23.76	0.46
NN50 count	26.65 ± 41.65	25.69 ± 45.62	0.88
PNN50%	11.82 ± 26.33	8.88 ± 14.46	0.31
R-R interval	701.24 ± 152.20	716.73 ± 167.49	0.52
SD1	24.05 ± 32.72	20.71 ± 18.12	0.37
SD2	31.51 ± 22.90	33.02 ± 17.80	0.62
Scatter index	0.66 ± 0.54	0.85 ± 2.84	0.59

Table 4: Effect of Glycaemic control on HRV parameters (cumulating HTD, NTD)

HRV parameter	Good control (n=28) (mean±SD)	Poor control (n=75) (mean±SD)	P value
VLF power	774.74 ± 741.09	414.50 ± 506.63	**0.0059***
LF power	543.90 ± 546.57	322.79 ± 527.83	0.66
HF power	1044.29 ± 1923.62	462.18 ± 1287.33	0.08
LF (nu)	0.52 ± 0.20	0.58 ± 0.21	0.22
HF (nu)	0.48 ± 0.20	0.41 ± 0.21	0.16
Maximum LF	0.07 ± 0.03	0.16 ± 0.80	0.55
Maximum HF	0.28 ± 0.08	0.28 ± 0.10	0.97
LF/HF ratio	1.63 ± 1.45	2.47 ± 3.40	0.21
Mode value	620.67 ± 176.10	705.82 ± 169.44	**0.0306***
Triangular HRV Index	5.94 ± 2.94	5.13 ± 2.59	0.17
SDNN	38.27 ± 29.65	32.77 ± 50.30	0.59
RMSSD	43.13 ± 54.09	27.21 ± 47.11	0.15
SDSD	32.69 ± 28.50	26.07 ± 48.57	0.51
NN50 count	41.46 ± 69.13	15.27 ± 37.63	**0.0157***
PNN50%	14.20 ± 21.73	15.27 ± 37.63	0.89
R-R interval	640.60 ± 172.42	703.55 ± 150.79	0.07
SD1	28.62 ± 28.00	17.57 ± 24.81	0.06
SD2	35.64 ± 17.88	25.95 ± 18.34	**0.0182***
Scatter index	0.71 ± 0.42	0.60 ± 0.37	0.19

Table 5: Effect of blood pressure control on HRV parameters (cumulating HTD, HTND, NTD)

HRV parameter	Good control (n=84) (mean±SD)	Poor control (n=69) (mean±SD)	P value
VLF power	449.09 ± 578.21	503.43 ± 644.99	0.60
LF power	351.28 ± 526.57	630.77 ± 1092.85	**0.0401***
HF power	568.21 ± 1680.80	234.80 ± 672.60	0.10
LF (nu)	0.54 ± 0.22	0.51 ± 0.21	0.39
HF (nu)	0.38 ± 0.25	0.23 ± 0.20	**<0.0001***
Maximum LF	0.18 ± 0.76	0.17 ± 0.11	0.90
Maximum HF	0.52 ± 1.02	0.80 ± 1.39	**0.0059***
LF/HF ratio	1.44 ± 1.29	2.23 ± 1.87	**<0.0001***
Mode value	884.16 ± 303.09	296.19 ± 339.50	**<0.0001***
Triangular HRV index	9.56 ± 11.34	20.08 ± 20.14	**<0.0001***
SDNN	29.04 ± 30.40	36.96 ± 48.09	0.22
RMSSD	31.99 ± 53.25	28.27 ± 23.77	0.59
SDSD	26.85 ± 47.42	23.62 ± 29.87	0.62
NN50 count	21.70 ± 49.00	13.61 ± 30.52	0.24
PNN50%	11.01 ± 24.17	15.82 ± 20.38	0.19
R-R interval	696.72 ± 161.13	664.63 ± 153.24	0.34
SD1	22.85 ± 27.45	26.59 ± 20.16	0.35
SD2	24.15 ± 21.06	14.20 ± 17.54	**0.00211***
Scatter index	129.47 ± 305.60	376.79 ± 391.66	**<0.0001***

Discussion

Five minutes HRV was evaluated in four groups namely- non-diabetic normotensive, diabetic normotensive, non-diabetic hypertensive, diabetic hypertensive. It allowed us to test prevalent effect of existing or non-existing diabetes (DM) and/or hypertension (HTN) on HRV as well as of risk factors of reduced HRV like age, gender, glycaemic control and blood pressure control.

Reduced HRV was observed in presence of DM and/or HTN as compared to controls, in accordance with previous [9-14] studies. However, in this study, we could compare all four possibilities with risk factors DM and HTN, that's missing in most studies. Reduced RR variability was evident in all three HRV domains-time domain, frequency domain and geometric domain. It was about half in presence of DM or HTN as compared to normal. Reduced HRV should be viewed in light of factors like age [15] (higher in diseased group than fourth group), poor glycaemic control [14], [16], poor blood pressure control [12],[14], physical inactivity [17] in our population, poor health literacy [18]. Sympatho-vagal balance was evaluated by LF/HF ratio which is normally 1.5-2 with higher ratio indicating symaptho-vagal imbalance. Amongst three diseased groups, diabetics (normotensive or hypertensive) had significantly and abnormally high LF/HF, but non-diabetics (hypertensive) had normal mean LF/HF ratio. This indicates DM to have more adverse effects on HRV than HTN. Traditionally, in cardiac autonomic neuropathy, there is an early phase of parasympathetic function loss with increased resting heart rate and abnormalities in the expiration/inspiration ratio of heart rate variability. There might, however, be no parasympathetic denervation as such, but simply early augmentation of sympathetic tone. Early in the natural history of diabetes, there is impairment of parasympathetic function, with a relative increase of sympathetic function causing an imbalance of the sympathetic/parasympathetic tone. Later, sympathetic denervation follows, beginning at the apex of the ventricles and progressing towards the base of the heart, leading to yet another imbalance, with an increase in propensity to arrhythmias [19]. Even the prediabetic stage (i.e., impaired glucose tolerance) is associated with a decreased parasympathetic modulation of the heart and a shift toward augmented sympathetic tone. Thus, parasympathetic tone might decline with an autonomic imbalance shifting toward augmented sympathetic tone during the development from normal glucose tolerance to

impaired glucose tolerance and finally diabetes [20]. The better HRV in diabetic hypertensives than diabetic non hypertensives can also be explained by the fact that the former group used anti-hypertensive drugs including beta blockers. These drugs are known to improve HRV and cardiac dysautonomia. [21] But, normotensive diabetics are usually not offered beta blockers or other antihypertensive in the absence of detected hypertension; so, they have comparatively poor HRV. In diabetics, blood pressure screening could be as poor as glycaemic control so early diagnosis is warranted to tide over aftermaths of it.

Study groups had significantly different gender distribution, so gender was the confounder. However, no significant difference was found between males and females in HRV amongst all three diseased groups. This is supported by previous study done in our region with comparable age groups and conditions.[7],[8] It is also supported by the documented evidence that beyond age 50, gender differences disappeared for all measures of HRV.

Individuals with optimum plasma glucose control had better HRV but this was a small and insignificant difference. This is supported by a study where they found no impact of glycemic control on HRV in diabetics and another one where glycaemic control was not related to autonomic function tests other than HRV in diabetics.[6] Abnormal sympatho vagal balance ensues even before incident diabetes [22] with genetic predisposition for the same. Detection of diabetes in India is often late, letting uncorrected hyperglycemia affect cardiac autonomic fibers adversely. The above-mentioned results and facts highlight the importance of early detection of diabetes and hyperglycemia as a major source for HRV abnormality. It can also be supported by the fact that glycemic control was very poor in diabetics and real effect of the same cannot be ascertained in small groups. Similarly, glycaemic variability per se is more important than point control of glycemia.[23] We also had major limitation that HbA1c was not available in our study that gives long term and more reliable glycemic control [14] than FPG or 2hPG. However, poor glycemics had abnormally high LF/HF ratio indicating sympatho vagal imbalance.

Individuals with blood pressure control showed better HRV in diseased group, in line with studies [14],[21] done elsewhere. Most differences between groups based on blood pressure control were statistically significant. These two facts, with lack of significant impact of glycaemic control on HRV, point to the importance of blood pressure over glycemia for cardiac autonomic balance. The poor blood pressure is rather the aftermath of cardiac dysautonomia [24] that's reflected as reduced HRV and high LF/HF ratio. Another fact is variability of blood pressure [25] which has major relevance for cardiovascular homeostasis and cardiovascular disease than point blood pressure, and same can better correlate with HRV. But HRV is measured in a controlled environment with averaging of five-minute data to consider all possible fluctuations. Uncontrolled blood pressure was related to LF/HF ratio significantly highlighting the sympathetic over activity underlying it.

Cardiac autonomic neuropathy (CAN) is a common and often overlooked diabetes-related complication which has a major impact on mortality and morbidity in patients with DM and HTN. Electrocardiographic RR intervals fluctuate cyclically, modulated by ventilation, baroreflexes, and other genetic and environmental factors that are mediated through the autonomic nervous system.[26] Short term electrocardiographic recordings (5 to 15 minutes), made under controlled conditions, e.g., lying supine or standing or tilted upright can elucidate physiologic, pharmacologic, or pathologic changes in autonomic nervous system function.[26] HRV clubs both sympathetic and parasympathetic function testing by single setting in quantifiable manner. Analysis of HRV has been used to assess autonomic function and/or to quantify risk in a wide variety of both cardiac and noncardiac disorders. A reduction in HRV is associated with the early stages of clinical cardiac autonomic neuropathy. It can be used to screen those at risk to insinuate timely intervention. Especially, the LF/HF ratio is the parameter to look for cardiac autonomic balance. In our study, as well, the ratio was significantly associated with risk factors like DM, HTN, gender, glycaemic control and blood pressure control.

Diabetes and hypertension are modern epidemics with multiple complications common to both. One of the most under- diagnosed complications is neuropathy- autonomic more than peripheral. [6] In the light of sub-optimum disease control and lack of lifestyle interventions in subjects like ours, it is a good candidate to use for clinical disease making [27] and disease management like HRV biofeedback [28]. Recently, even ultra short HRV is found to be valid to diagnose cardiac autonomic neuropathy.[29] HRV, being an objective tool can be used even at primary care level to screen at risk, looking at the burden of diabetics and/or hypertensives being treated at primary care level. Inclusion of HRV can improvise risk stratification in HTN or DM and further research is required in this field.

Present study has its limitations like- cross-sectional nature, moderate sample size, 5 min short HRV, lack of biomarkers like HbA1c.These can be sorted out by further studies using baseline data with vertical follow up, getting all biomarkers done to test long term HRV recording on large scale.

Conclusion

Compared to normative, HRV is reduced in both diabetics more than hypertensives; related to blood pressure control more than glycaemic control. It points altered cardiac autonomic balance, and the possibility of cardiovascular morbidity and mortality. It hints early detection of diabetes, hypertension and timely intervention. It also calls for investigation of same for reinforcement of our observations and further exploration.

References

1. Thankappan KR, Daivadanam M, Mini GK, Joshi R, Sathish T. Awareness, Treatment, and Control of Hypertension or Diabetes in India: The Impact of Public Health Promotion. *Front Public Health*. 2022:**1244**.
2. Solanki JD, Makwana AH, Mehta HB, Gokhale PA, Shah CJ. Hypertension in type 2 diabetes mellitus: Effect of the disease and treatment on development of peripheral artery disease. *Int J Diabetes Dev Ctries*. 2015; **35**:380-4.
3. Chowdhury M, Nevitt S, Eleftheriadou A, Kanagala P, Esa H, Cuthbertson DJ, et al. Cardiac autonomic neuropathy and risk of cardiovascular disease and mortality in type 1 and type 2 diabetes: a meta-analysis. *BMJ Open Diabetes Res Care.* 2021; **9**:e002480.
4. Pham T, Lau ZJ, Chen SH, Makowski D. Heart rate variability in psychology: a review of HRV indices and an analysis tutorial. *Sensors.* 2021; **21**:3998.
5. Hoshi RA, Santos IS, Dantas EM, Andreão RV, Mill JG, Lotufo PA,et al. Reduced heart-rate variability and increased risk of hypertension—A prospective study of the ELSA-Brasil. *J Hum Hypertens*. 2021; **35**:1088-97.
6. Duque A, Mediano MF, De Lorenzo A, Rodrigues Jr LF. Cardiovascular autonomic neuropathy in diabetes: Pathophysiology, clinical assessment and implications. *World J Diabetes*. 2021; **12**:855-67.
7. Solanki JD, Basida SD, Mehta HB, Panjwani SJ, Gadhavi BP, Patel P. Impact of disease control and co-existing risk factors on heart rate variability in Gujarati type 2 diabetics: An observational study. *J Family Med Prim Care*. 2016; **5**:393-8.
8. Solanki JD, Basida SD, Mehta HB, Panjwani SJ, Gadhavi BP. Comparative study of cardiac autonomic status by heart rate variability between under-treatment normotensive and hypertensive known type 2 diabetics. *Indian Heart J*. 2017; **69**:52-6.
9. Verma S, Bhati P, Ahmad I, Masroor S, Ali K, Singla D, et al. Co-Existence of hypertension worsens post-exercise cardiac autonomic recovery in type 2 diabetes. *Indian Heart J*. 2018; **70** (Suppl 3): S82-S89.
10. Mejía-Mejía E, May JM, Torres R, Kyriacou PA. Pulse rate variability in cardiovascular health: A review on its applications and relationship with heart rate variability. *Physiol Meas.* 2020; **41**:07TR01.
11. Martinez PF, Okoshi MP. Heart rate variability in coexisting diabetes and hypertension. *Arq Bras Cardiol*. 2018; **111**:73-4.

12. Hoshi RA, Santos IS, Dantas EM, Andreão RV, Schmidt MI, Duncan BB, et al. Decreased heart rate variability as a predictor for diabetes—A prospective study of the Brazilian longitudinal study of adult health. *Diabetes Metab Res Rev*. 2019; **35**:e3175.
13. De Barros JA, Macartney MJ, Peoples GE, Notley SR, Herry CL, Kenny GP. The impact of age, type 2 diabetes and hypertension on heart rate variability during rest and exercise at increasing levels of heat stress. *Eur J Appl Physiol*. 2022; **122**:1249-59.
14. Tsubokawa M, Nishimura M, Tamada Y, Nakaji S. Factors Associated with Reduced Heart Rate Variability in the General Japanese Population: The Iwaki Cross-Sectional Research Study. *Healthcare*. 2022; **10**:793,
15. Garavaglia L, Gulich D, Defeo MM, Thomas Mailland J, Irurzun IM. The effect of age on the heart rate variability of healthy subjects. *PLoS One*. 2021; **16**:e0255894.
16. Rajendran R, Sharma VK, Vinod KV, Ananthakrishnan R, Nandeesha H, Subramanian SK. Comparison of cardiac autonomic function across complete glycaemic spectrum. *J Basic Clin Physiol Pharmacol*. 2022: **0053**.
17. Alansare AB, Bates LC, Stoner L, Kline CE, Nagle E, Jennings JR, et al. Associations of sedentary time with heart rate and heart rate variability in adults: a systematic review and meta-analysis of observational studies. *Int J Environ Res Public Health*. 2021; **18**:8508.
18. Solanki JD, Sheth NS, Shah CJ, Mehta HB. Knowledge, attitude, and practice of urban Gujarati type 2 diabetics: Prevalence and impact on disease control. *J Educ Health Promot.* 2017; 6:35.
19. Vinik A, Maser R, Ziegler D. Autonomic Imbalance: Prophet of Doom or Scope for Hope? *Diabet Med.* 2011; **28**:643–51.
20. Wu JS, Yang YC, Lin TS, Huang YH, Chen JJ, Lu FH, et al. Epidemiological evidence of altered cardiac autonomic function in subjects with impaired glucose tolerance but not isolated impaired fasting glucose. *J Clin Endocrinol Metab.* 2007; **92**:3885–9.
21. Maciorowska M, Krzesiński P, Wierzbowski R, Uziębło-Życzkowska B, Gielerak G. Associations between Heart Rate Variability Parameters and Hemodynamic Profiles in Patients with Primary Arterial Hypertension, Including Antihypertensive Treatment Effects. *J Clin Med.* 2022; **11**:3767.
22. Eleftheriadou A, Williams S, Nevitt S, Brown E, Roylance R, Wilding JP, et al. The prevalence of cardiac autonomic neuropathy in prediabetes: a systematic review. *Diabetologia.* 2021; **64**:288-303.
23. Martinez M, Santamarina J, Pavesi A, Musso C, Umpierrez GE. Glycemic variability and cardiovascular disease in patients with type 2 diabetes. *BMJ Open Diabetes Res Care.* 2021; **9**: e002032.
24. Hoshi RA, Santos IS, Dantas EM, Andreão RV, Mill JG, Lotufo PA,et al. Reduced heart-rate variability and increased risk of hypertension—A prospective study of the ELSA-Brasil. *J Hum Hypertens.* 2021; **35**:1088-97.
25. Parati G, Torlasco C, Pengo M, Bilo G, Ochoa JE. Blood pressure variability: its relevance for cardiovascular homeostasis and cardiovascular diseases. *Hypertens Res.* 2020; **43**:609-20.
26. Kleiger RE, Stein PK, Bigger JT. Heart rate variability: measurement and clinical utility. *Ann Noninvasive Electrocardiol.* 2005; **10**:88-101.
27. Forte G, Morelli M, Casagrande M. Heart rate variability and decision-making: Autonomic responses in making decisions. *Brain Sci.* 2021; **11**:243.
28. Fournié C, Chouchou F, Dalleau G, Caderby T, Cabrera Q, Verkindt C. Heart rate variability biofeedback in chronic disease management: A systematic review. *Complement Ther Med.* 2021; **60**:102750.
29. Wehler D, Jelinek HF, Gronau A, Wessel N, Kraemer JF, Krones R, et al. Reliability of heart-rate-variability features derived from ultra-short ECG recordings and their validity in the assessment of cardiac autonomic neuropathy. *Biomed Signal Process Control.* 2021; **68**:102651.