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Research Article

Heart Rate Variability in Young Adults with and without Family History of Hypertension: A Cross-Sectional Study

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ABSTRACT

Introduction: Hypertension (HTN) is a major modifiable risk factor for cardiovascular disease and a leading cause of morbidity and mortality worldwide. Alterations in heart rate variability (HRV) have been associated with significant changes in cardiovascular outcomes, making HRV a clinically relevant marker in hypertensive individuals.
Objective: To evaluate and compare heart rate variability parameters in young adults with and without a family history of hypertension.
Materials and Methods: A cross-sectional study was conducted at Gandhi Medical College, Secunderabad, including 80 participants. Among them, 40 subjects had a family history of hypertension and 40 subjects had no such history. HRV was analyzed using time domain indices (NN interval, mean RR interval, SDNN, RMSSD) and frequency domain indices (total power, low frequency [LF], high frequency [HF], and LF/HF ratio).
Results: Frequency domain analysis showed an increase in LF (nu) values in subjects with a family history of hypertension, indicating increased sympathetic activity. A significant reduction in HF (nu) values ($p = 0.04$) was observed, suggesting decreased parasympathetic activity. RMSSD was also significantly reduced ($p = 0.04$), indicating reduced vagal tone.
Conclusion: Normotensive individuals with a family history of hypertension exhibit early autonomic imbalance characterized by increased sympathetic activity and reduced parasympathetic activity. HRV analysis may serve as a useful tool for early identification of individuals at risk of developing hypertension.

Keywords*: Heart Rate Variability, Hypertension, Autonomic Nervous System, Family History.*

INTRODUCTION

Hypertension is one of the most prevalent non-communicable diseases globally and a major contributor to cardiovascular morbidity and mortality. It is estimated that over one billion individuals worldwide are affected, with a disproportionately higher burden in low- and middle-income countries such as India[1,2]. In India, the prevalence of hypertension is approximately 25–30% in urban populations and 10–15% in rural populations, with an increasing trend due to urbanization and lifestyle changes[2].

Family history is a well-established non-modifiable risk factor for hypertension, reflecting genetic predisposition and shared environmental influences. Offspring of hypertensive parents are at increased risk of developing hypertension compared to those without such a history[3]. These individuals may exhibit early physiological changes even before clinical onset.

The autonomic nervous system (ANS) plays a critical role in cardiovascular regulation. Dysregulation of ANS, characterized by increased sympathetic activity and reduced parasympathetic activity, has been implicated in the development of essential hypertension[11].

Heart rate variability (HRV) is a non-invasive and reliable tool used to assess autonomic function by measuring variations in the RR intervals between successive heartbeats[10]. Reduced HRV has been associated with increased cardiovascular morbidity, including hypertension, myocardial infarction, and heart failure[12].

HRV can be analyzed using time domain and frequency domain parameters. Standardized methods for HRV analysis have been established and are widely used in clinical and research settings[9].

Recent studies have demonstrated that individuals with a family history of hypertension exhibit altered HRV parameters even in the normotensive state, suggesting early autonomic dysfunction[4–8]. These findings indicate that autonomic imbalance may precede the development of overt hypertension.
Therefore, the present study was undertaken to evaluate HRV parameters in young adults with and without a family history of hypertension.

MATERIALS AND METHODS:

Study Design and Setting

This cross-sectional observational study was conducted in the Department of Physiology at Gandhi Medical College, Secunderabad.

Study Population

A total of 80 healthy young adults aged between 18 and 25 years were included in the study.

Participants were divided into two groups:

- Group A (Study Group): 40 individuals with a positive family history of hypertension (either parent diagnosed with hypertension)
- Group B (Control Group): 40 individuals without any family history of hypertension

Inclusion Criteria

- Healthy individuals aged 18–25 years
- Both males and females
- Willing to participate and provide informed consent

Exclusion Criteria

- Known cases of hypertension, diabetes mellitus, or cardiovascular disease
- History of smoking, alcohol consumption, or substance abuse
- Individuals on medications affecting autonomic function
- Acute illness or chronic systemic disease

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment.

Study Procedure:

Participants were instructed to Avoid caffeine, heavy meals, and strenuous exercise for at least 12 hours prior to the test Report in a relaxed state
All recordings were performed in a quiet, temperature-controlled room with subjects in the supine position after adequate rest (10–15 minutes).

HRV Recording

Electrocardiographic (ECG) recordings were obtained under resting conditions in a quiet environment. HRV analysis was performed using standardized guidelines as recommended by the Task Force of the European Society of Cardiology[9].

Parameters Studied

Time Domain Parameters

- Mean RR Interval (ms): Average time between successive heartbeats
- SDNN (ms): Standard deviation of all NN intervals, representing overall HRV
- RMSSD (ms): Root mean square of successive differences, reflecting parasympathetic activity

Frequency Domain Parameters

- Low Frequency (LF, nu): Reflects both sympathetic and parasympathetic activity but predominantly sympathetic when expressed in normalized units
- High Frequency (HF, nu): Reflects parasympathetic (vagal) activity
- LF/HF Ratio: Indicator of sympathovagal balance

These parameters reflect autonomic balance, with HF representing parasympathetic activity and LF reflecting both sympathetic and parasympathetic influences[10].

Statistical Analysis

Statistical analysis was performed using SPSS 20.0. Data were expressed as mean ± SD and analyzed using Student's unpaired t-test. A p-value < 0.05 was considered statistically significant.

RESULTS:

A total of 80 participants were included in the study, comprising 40 subjects with a family history of hypertension (study group) and 40 subjects without a family history (control group). Heart rate variability (HRV) parameters were analyzed using both time domain and frequency domain methods to assess autonomic function.

There was no statistically significant difference in age, height, weight, or body mass index (BMI) between subjects with and without a family history of hypertension (p > 0.05). (Table 1)

Table 1: Anthropometric parameters in subjects with and without family history of hypertension

	Subjects with family history of hypertension		Subjects without family history of hypertension		
	MEAN	SD	MEAN	SD	P value
Age (years)	19.25	0.78	19.60	0.93	0.07
Height (cm)	1.69	0.08	1.69	0.09	0.48
Weight (kg)	62.96	10.47	65.03	10.86	0.38
BMI	22.11	3.12	22.46	2.82	0.59

There was no statistically significant difference in mean heart rate, mean RR interval, or SDNN between the two groups. However, RMSSD was significantly reduced in subjects with a family history of hypertension (p = 0.04), indicating decreased parasympathetic (vagal) activity in these individuals. (Table 2)

Table 2: Time Domain Parameters in Subjects With and Without Family History of Hypertension

Parameter	**Family History (Mean ± SD)**	**No Family History (Mean ± SD)**	**p-value**
Mean HR (beats/min)	87.78 ± 9.91	86.84 ± 11.52	0.70
Mean RR (ms)	699.17 ± 74.81	700.36 ± 93.27	0.95
SDNN (ms)	61.63 ± 25.56	58.94 ± 26.51	0.65
RMSSD (ms)	39.10 ± 14.30	45.59 ± 14.10	**0.04***
SDSD (ms)	40.52 ± 16.35	44.64 ± 16.35	0.26

In the frequency domain analysis, LF values were higher in subjects with a family history of hypertension compared to controls, although this difference was not statistically significant. HF values were significantly reduced (p = 0.04), indicating reduced parasympathetic activity. The LF/HF ratio was increased in the study group, but this difference was not statistically significant. These findings suggest a trend toward sympathetic predominance and reduced vagal modulation in subjects with a family history of hypertension. (Table 3)

Table 3: Frequency Domain Parameters in Subjects With and Without Family History of Hypertension

Parameter	Family History (Mean ± SD)	No Family History (Mean ± SD)	p-value
LF (nu)	53.56 ± 17.73	48.50 ± 18.12	0.21
HF (nu)	42.60 ± 14.71	49.93 ± 17.84	0.04*
LF/HF Ratio	1.53 ± 1.02	1.33 ± 1.28	0.43

DISCUSSION:

The present study demonstrates early autonomic imbalance in normotensive individuals with a family history of hypertension. The findings of increased LF and decreased HF suggest a shift toward sympathetic dominance and reduced parasympathetic activity.

The LF component, particularly when expressed in normalized units, is considered an indicator of sympathetic activity, while HF is a direct measure of vagal tone[10]. The observed reduction in HF in the study group indicates decreased parasympathetic activity, which plays a protective role in cardiovascular regulation.

The reduction in RMSSD further supports decreased vagal modulation. RMSSD is a sensitive marker of short-term HRV and parasympathetic activity[10]. Reduced vagal tone has been associated with increased cardiovascular risk and progression of hypertension[12].

These findings are consistent with previous studies that have reported altered HRV parameters in individuals with a family history of hypertension[5],[8]. Increased sympathetic activity and reduced parasympathetic activity may represent early pathophysiological changes preceding the onset of hypertension.

Although the LF/HF ratio was increased in the study group, it was not statistically significant. The LF/HF ratio has traditionally been used as an indicator of sympathovagal balance; however, its interpretation remains controversial and should be used cautiously[7].

The underlying mechanisms may involve genetic predisposition, altered baroreceptor sensitivity, and early vascular changes that influence autonomic regulation[11]. Increased sympathetic activity may lead to vasoconstriction and increased cardiac workload, ultimately contributing to the development of hypertension.

Thus, HRV analysis serves as a valuable, non-invasive tool for detecting early autonomic dysfunction. Early identification of at-risk individuals may allow implementation of preventive strategies such as lifestyle modification and regular monitoring.

CONCLUSION:

The present study demonstrates that normotensive young adults with a family history of hypertension exhibit early autonomic dysfunction, evidenced by reduced RMSSD and HF components indicating decreased parasympathetic activity, along with a trend toward sympathetic predominance. These findings suggest that autonomic imbalance may precede the clinical onset of hypertension, placing such individuals at a higher risk of developing the condition. Heart rate variability analysis, being a simple and non-invasive tool, may be useful for early detection and preventive management in high-risk individuals.

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