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RESEARCH ARTICLE

HEART RATE VARIABILITY IN OFFSPRING OF NORMOTENSIVE AND HYPERTENSIVE PARENTS: A COMPARATIVE STUDY

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Abstract

Objective: This study aims to evaluate the differences in heart rate variability (HRV), a biomarker of autonomic nervous system, between offspring of normotensive and hypertensive parents to understand the genetic predisposition of autonomic dysfunction.

Methods: This study was a cross-sectional observational study.Two groups of healthy adults, offspring of parents with hypertension (n = 50) and offspring of parents with normal blood pressure (n = 50). Short-term HRV was measured using 5-minute electrocardiogram (ECG). HRV indices such as time and frequency domainwere measured. Data were compared by using independent t-tests, with $p < 0.05$ being considered as statistically significant.

Results: The offspring of parents with hypertension showed significantly lower HRV, with SDNN (30.5 ± 8.2 ms) compared to offspring of parents with normal blood pressure (45.2 ± 7.1 ms, $p < 0.001$). RMSSD also was significantly lower in offspring of hypertensive group. Low-frequency (LF) power was higher in offspring of parents with hypertension,while high-frequency (HF) power was significantly reduced in them compared to the normotensive group. The LF:HF ratio was higher in offspring of parents with hypertension (2.80 ± 0.85) compared to the normotensive group (1.40 ± 0.60, $p < 0.001$), indicating sympathovagal imbalance.

Conclusion: Offspring of parents with hypertension hadlower HRV, suggesting autonomic dysfunction even in the absence of clinical hypertension. These findings emphasize the potential role of genetic predisposition in the early onset of autonomic dysregulation Further studies are required to understand mechanisms contributing to these differences in HRV.

Introduction:-

Cardiac function is regulated by autonomic nervous system (ANS) (Kamath et al., 2016).Function of ANS is assessed by using a sensitive biomarker known asHeart Rate Variability (HRV). A higher HRV indicates a better cardiovascular (CV) health. It is associated with decrease in adverse CV outcomes such as hypertension and heart disease. Whereas, a lower HRV indicates increased CV risk (Akselrod et al., 1981; Electrophysiology, 1996).

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About 40 % of essential hypertension is attributable to genetic cause (Weder, 2007). Due to a higher genetic predisposition, individuals with family history of hypertension have a higher likelihood of developing hypertension (Bansal et al., 2023; Whelton et al., 2018).

ANS has a major physiological role in regulating the blood pressure. Dysfunction of ANS, in form of increased sympathetic drive has a causative role in development of hypertension. Earlier studies showed that there is a strong association between autonomic dysfunction and elevated blood pressure (Singh et al., 1998). Hence, the offspring of parents with hypertension may show signs of autonomic dysregulation, even before they develop hypertension clinically (Calvillo et al., 2019; Sing et al., 2003).

Therefore, this study aims to compare HRV in offspring of parents with hypertension with offspring of normotensive parents, to understand the role of parental hypertension in autonomic dysfunction.

Materials and Methods:-

Participants

100 healthy normotensive adults were recruited in the study (50 offspring of parents with hypertension and 50 offspring of parents with normal blood pressure). Offspring of parents with hypertension were defined as individuals with at least one parent diagnosed with clinical hypertension, while offspring of normotensive parents had both parents with normal blood pressure (defined as BP < 140/90 mmHg) (Muntner et al., 2018). We included participants aged 20-40 years, with no history of hypertension, cardiovascular disease and diabetes.

Sample Size Calculation

The required sample size for each group was calculated to be 50 participants using an effect size (Cohen's d) of 0.8, a power of 0.80, and a significance level of 0.05 using previous study (Kraja et al., 2011).

Study Design

This was a cross-sectional observational study. After obtaining informed consent, the participants underwent short-term HRV assessment by 5-minute ECG monitoring using the instrument PHYSIOPAC-PP4, Medicaid system, Chandigarh. HRV indices (time-domain and frequency-domain) were analyzed ("Heart Rate Variability," 1996).

HRV Measurement

Short-term HRV was measured using 5 minutes of ECG recordings.
Time-domain measures included:

- **SDNN (standard deviation of normal RR intervals)**. It serves a marker of overall HRV.
- **RMSSD (root mean square of successive differences)**: It is a measure of parasympathetic activity.

Frequency-domain measures included:

- **LF (low-frequency power)**, an indicator of sympathetic activity.
- **HF (high-frequency power)**, a measure of parasympathetic activity.
- **LF:HF Ratio**, serves as an indicator that denotes the balance of sympathetic and parasympathetic function ("Heart Rate Variability," 1996; Pal et al., 2011).

Statistical Analysis

The study variables are presented as mean ± standard deviation. Comparison between the groups were conducted using independent t-tests, with a p-value of less than 0.05 being regarded as statistically significant.

Results:-

Demographic Characteristics

Table number 1 summarize the demographic details of the study participants. There were no significant differences in demographic characters like age and body mass index between the participants.

Table 1:- Demographic details.

Characteristic	Offspring of Parents with hypertension (n=50)	Offspring of Parents with normal blood pressure (n=50)	p-value

Characteristic	Offspring of Parents with hypertension (n=50)	Offspring of Parents with normal blood pressure (n=50)	p-value
Age (years)	28.1 ± 5.1	28.6 ± 5.2	0.65
BMI (kg/m²)	24.8 ± 3.6	24.3 ± 3.4	0.59

HRV Parameters

Short-term HRV values for the participants are summarized in Table 2 and 3. Offspring of parents with hypertension exhibited significantly lower SDNN, RMSSD, and HF, indicating decreased parasympathetic activity. Additionally, there was an increase in the LF: HF, indicating heightened sympathovagal imbalance.

Table 2:- Time Domain Parameters.

Parameter	Offspring of Parents with hypertension (n=50)	Offspring of Parents with normal blood pressure (n=50)	p-value
SDNN (ms)	30.5 ± 8.2	45.2 ± 7.1	< 0.001
RMSSD (ms)	20.6 ± 5.4	33.1 ± 6.7	< 0.001

Table 3:- Frequency Domain Parameters.

Parameter	Offspring of Parents with hypertension (n=50)	Offspring of Parents with normal blood pressure (n=50)	p-value
LF (ms²)	159.5 ± 53.7	120.8 ± 49.9	0.02
HF (ms²)	80.5 ± 35.2	144.2 ± 47.5	< 0.001
LF: HF Ratio	2.80 ± 0.85	1.40 ± 0.60	< 0.001

Discussion:-

Our findings demonstrate that offspring of parents with hypertension have lower heart rate variability when compared to offspring of normotensive parents; which is consistent with the findings from previous researches (Lloyd-Jones et al., 2004; Wu et al., 2008). The offspring of hypertensive parents exhibit significantly lower parasympathetic activity and increased sympathetic activity, suggestive of sympathovagal imbalance. This shows that even in the absence of clinical hypertension, offspring of parents with hypertension experience early autonomic dysfunction, which is associated with high cardiovascular risk.

The observed changes in HRV in offspring of parents with hypertension could be attributed to genetic predispositions associated with hypertension (Wu et al., 2008). Given the hereditary nature of hypertension, it is essential to target this high-risk population with early interventions that promote healthy lifestyle choices. Adopting healthy diet, regular exercise and adhering to good sleep hygiene may reduce the cardiovascular and support better health outcomes in long-term.

Limitations

Confounding factors like physical activity and sleep quality were not directly measured this in study, which could influence HRV.

Conclusion:-

This study provides evidence that autonomic dysregulation may occur early in the offspring of parents with hypertension, potentially increasing the risk for developing hypertension and other cardiovascular diseases in the future. Future research should explore the underlying genetic mechanisms driving these differences in HRV and develop early intervention strategies to reduce cardiovascular risk.

Conflict of Interest Statement

None.

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