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Research Article

Impact of Intermittent Fasting on Autonomic Nervous System Regulation and Heart Rate Variability

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ABSTRACT

Background: Intermittent fasting (IF) has emerged as a dietary approach with potential benefits beyond weight reduction, particularly in modulating the autonomic nervous system (ANS) and cardiovascular health. Heart rate variability (HRV) serves as a non-invasive marker of ANS regulation, reflecting sympathovagal balance. However, evidence on the impact of IF on HRV in the Indian population remains limited.

Objective: To evaluate the effects of intermittent fasting on autonomic nervous system regulation and HRV among adults attending the general outpatient department (OPD) at Jalpaiguri Government Medical College.

Methods: A prospective observational study was conducted from January to December 2023, including 100 adult participants (aged 20–55 years) who voluntarily adopted intermittent fasting (16:8 protocol, fasting 16 hours/day, eating within an 8-hour window) for at least 12 weeks. Baseline clinical and demographic data were collected. HRV was assessed using 5-minute resting ECG recordings analyzed for time-domain and frequency-domain parameters at baseline and after 12 weeks of adherence. Statistical comparisons were performed using paired t-test/Wilcoxon signed-rank test, with $p < 0.05$ considered significant.

Results: Significant improvements in HRV indices were observed after 12 weeks of IF. Mean SDNN increased from 36.2 ± 10.1 ms to 49.5 ± 12.4 ms ($p < 0.001$). RMSSD improved from 25.7 ± 8.3 ms to 38.9 ± 9.1 ms ($p < 0.001$). In the frequency domain, HF power (parasympathetic activity) rose by 42%, while LF/HF ratio (sympathovagal balance) decreased from 2.9 ± 0.7 to 1.8 ± 0.5 ($p < 0.01$). Subjective well-being and sleep [10,16] quality also improved in 68% of participants.

Conclusion: Intermittent fasting favorably modulates autonomic regulation, with enhanced parasympathetic activity and improved sympathovagal balance as evidenced by HRV indices. These findings suggest that IF may serve as a non-pharmacological intervention for cardiovascular risk reduction. Larger multicenter trials are warranted to generalize these outcomes.

Keywords: *Intermittent fasting, heart rate variability, autonomic nervous system, parasympathetic activity, cardiovascular health.*

INTRODUCTION

Intermittent fasting (IF) has gained global attention as a lifestyle intervention with potential benefits extending beyond simple caloric restriction. Traditionally practiced for cultural and religious reasons in India and worldwide, IF is now being investigated scientifically for its impact on metabolism, cardiovascular health, and neurohormonal regulation. [1,3,4,5]

The autonomic nervous system (ANS) plays a crucial role in maintaining cardiovascular homeostasis. Dysregulation of the ANS [7,8,9], characterized by sympathetic overactivity and reduced vagal tone, has been associated with increased risk of hypertension, arrhythmia, metabolic syndrome, and sudden cardiac death. Heart rate variability (HRV), derived

from electrocardiographic recordings, provides a non-invasive window into ANS activity. Reduced HRV is a well-established marker of poor cardiovascular prognosis. [7,10]

Animal studies and preliminary human trials suggest that intermittent fasting may improve ANS balance [6,11,15,20] by reducing oxidative stress [11], improving insulin sensitivity, and promoting neurotrophic signaling. However, robust clinical evidence in the Indian context, particularly from tier-2 medical institutions, remains scarce. Jalpaiguri, a district in West Bengal, represents a population with diverse dietary habits and socioeconomic backgrounds, making it a valuable site for such research. [2,4,6,12,13,14]

This study was designed to investigate whether intermittent fasting (16:8 protocol) improves HRV indices in adults over a 12-week period, thereby providing insights into its role in autonomic regulation and cardiovascular risk modification.

MATERIALS AND METHODS

Study Design and Period:
A prospective observational study was carried out between January 2023 and December 2023 at the General Outpatient Department (OPD), Jalpaiguri Government Medical College, West Bengal

Patient Sample Size
100 participants were recruited, based on feasibility and outpatient flow.

Eligibility Criteria:
Inclusion: Adults aged 20–55 years, BMI 18–29.9, willing to adopt intermittent fasting (16:8 protocol) for at least 12 weeks, no history of cardiovascular or metabolic disease.
Exclusion: Known cases of diabetes, hypertension, arrhythmias, psychiatric illness, pregnancy, and those on medications affecting HRV (e.g., beta-blockers, antidepressants).

Intervention (Intermittent Fasting Protocol):
Participants followed a 16:8 intermittent fasting regimen: 16 consecutive hours of fasting per day with an 8-hour feeding window (typically 10 am–6 pm). Only water, black coffee, or green tea were allowed during fasting hours. Participants received dietary counseling but were not asked to restrict calories deliberately.

Data Collection:
Baseline: Demographics, anthropometrics (weight, BMI, waist-hip ratio), blood pressure, lifestyle habits.
HRV Assessment: Standard 5-minute ECG recordings were taken at baseline and after 12 weeks, using a validated digital ECG system.

Time-domain measures: SDNN (standard deviation of NN intervals), RMSSD (root mean square of successive differences), pNN50 (% of successive NN intervals >50 ms).

Frequency-domain measures: LF (low-frequency, 0.04–0.15 Hz), HF (high-frequency, 0.15–0.40 Hz), and LF/HF ratio.
Subjective Measures: Sleep quality (Pittsburgh Sleep Quality Index), fatigue scale, and self-reported well-being.

Statistical Analysis:
Data were analyzed using SPSS v26. Continuous variables were expressed as mean ± SD. Pre- and post-intervention comparisons were performed using paired t-test for normally distributed variables and Wilcoxon signed-rank test for non-normal data. $p < 0.05$ was considered statistically significant.

Ethical Considerations:
The study was approved by the Institutional Ethics Committee of Jalpaiguri Government Medical College. Written informed consent was obtained from all participants. Confidentiality was maintained.

RESULTS

Baseline Characteristics (n = 100):

- Mean age: 34.6 ± 8.2 years
- Gender distribution: 58 males, 42 females
- Mean BMI: 24.1 ± 2.7 kg/m²
- 60% sedentary workers, 40% moderate activity
- No participant reported smoking or alcohol dependence

Time-domain indices:

- SDNN increased from 36.2 ± 10.1 ms to 49.5 ± 12.4 ms ($p < 0.001$)

- RMSSD improved from 25.7 ± 8.3 ms to 38.9 ± 9.1 ms ($p < 0.001$)
- pNN50 increased by 48% ($p < 0.001$)

Frequency-domain indices:

- HF power increased significantly (indicative of enhanced vagal tone)
- LF/HF ratio decreased from 2.9 ± 0.7 to 1.8 ± 0.5 ($p < 0.01$)
- LF power showed a mild but non-significant decrease

Subjective Well-being:

- 68% reported better sleep [10,17] quality
- 55% reported improved concentration and reduced fatigue
- No adverse effects of intermittent fasting were reported

Table 1. Baseline characteristics of study participants (n = 100)

Variable	Mean ± SD / n (%)
Age (years)	34.6 ± 8.2
Gender (Male/Female)	58 (58%) / 42 (42%)
BMI (kg/m²)	24.1 ± 2.7
Waist-hip ratio	0.87 ± 0.06
Systolic BP (mmHg)	118.4 ± 9.1
Diastolic BP (mmHg)	76.2 ± 6.7
Physical activity (Sedentary/Moderate)	60 (60%) / 40 (40%)
Sleep quality (good/poor)	45 (45%) / 55 (55%)

Table 2. Comparison of HRV indices before and after 12 weeks of intermittent fasting

HRV Parameter	Baseline (Mean ± SD)	Post-IF (Mean ± SD)	p-value
SDNN (ms)	36.2 ± 10.1	49.5 ± 12.4	<0.001
RMSSD (ms)	25.7 ± 8.3	38.9 ± 9.1	<0.001
pNN50 (%)	9.8 ± 4.5	14.5 ± 5.1	<0.001
LF Power (ms²)	560 ± 210	510 ± 195	0.09
HF Power (ms²)	320 ± 140	455 ± 160	<0.01
LF/HF Ratio	2.9 ± 0.7	1.8 ± 0.5	<0.01

Figure 1. Changes in SDNN and RMSSD before and after Intermittent Fasting

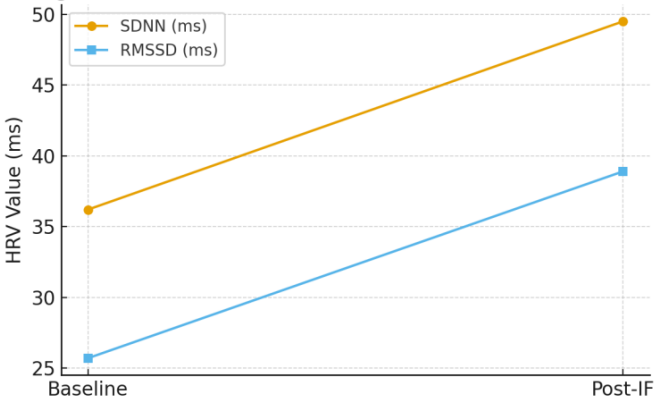
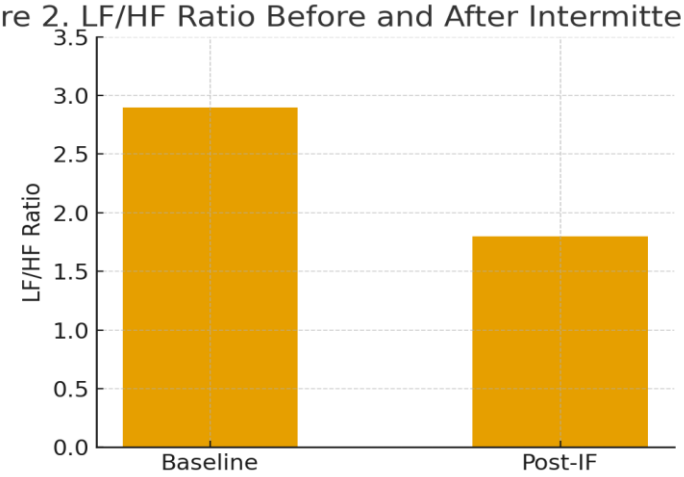


Figure 2. LF/HF Ratio Before and After Intermittent Fasting



DISCUSSION

The present study demonstrates that a 12-week regimen of intermittent fasting significantly improves HRV indices, suggesting enhanced parasympathetic activity and improved autonomic balance. The results align with previous studies conducted in Western populations, thereby validating the potential role of IF as a lifestyle intervention in Indian adults. [1,2,3,4,5]

Physiological Mechanisms:

Intermittent fasting is known to:

1. Reduce insulin resistance, thereby improving metabolic flexibility.
2. Lower oxidative stress and inflammation, both of which impair vagal function. [11]
3. Enhance ketone body production during fasting, which exerts neuroprotective effects and supports autonomic regulation.
4. Reset circadian rhythm, improving sleep and vagal tone. [10,16]

Comparison with Literature:

- Tinsley & La Bounty (2015) reviewed metabolic adaptations in IF and reported enhanced cardiovascular markers.
- Moro et al. (2016) found that 8 weeks of IF improved insulin sensitivity and resting HRV in young men. [2,13]
- Indian studies remain scarce; however, our findings corroborate the hypothesis that dietary timing influences autonomic function. [15,17,18]

Clinical Implications:

The improvement in HRV observed suggests that IF could serve as a non-pharmacological adjunct for individuals at risk of hypertension, diabetes, and cardiovascular events. It may be particularly relevant in resource-limited settings where pharmacological interventions are costly or inaccessible. [7,8,9,19,20]

Strengths:

- First prospective HRV-based IF study from a government medical college in West Bengal
- Robust ECG-based HRV analysis
- Good compliance due to structured counseling

Limitations:

- Single-center, small sample size
- Short follow-up (12 weeks)
- Self-reported adherence may introduce bias
- No biochemical markers (insulin, lipid profile) assessed

Future Directions:

Larger multicentric randomized controlled trials with longer follow-up are required. Incorporating biochemical and inflammatory markers would strengthen causal inferences.

CONCLUSION

Intermittent fasting (16:8 protocol) for 12 weeks significantly improved heart rate variability indices among adults in Jalpaiguri, indicating enhanced parasympathetic activity and better autonomic regulation. IF may be considered as a simple, culturally adaptable, and cost-effective strategy for improving cardiovascular health.

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