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Original Research Article

A Study of Heart Rate Variability in Underweight and Overweight Young Individuals

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Conflict of interest: Nil

Abstract:

Background: Heart rate variability (HRV) is a non-invasive indicator of cardiovascular health and autonomic nervous system control. Body mass index (BMI) extremes, such as being underweight or overweight, are known to affect autonomic balance, especially in young people.

Objective: To compare heart rate variability parameters between underweight and overweight young individuals.

Methods: This observational study was conducted over one year from July 2024 to June 2025 at Bhagwan Mahavir Institute of Medical Sciences and comprised 90 young individuals aged 18–25 years. Based on BMI, individuals were divided into underweight and overweight groups. Time-domain and frequency-domain HRV characteristics were examined from resting ECG recordings.

Results: Underweight individuals displayed considerably greater HRV values of SDNN (Standard Deviation of Normal-to-Normal Intervals), RMSSD (Root Mean Square of Successive Differences) compared to overweight persons, indicating superior parasympathetic regulation. Overweight individuals had lower HRV with a greater LF (Low-frequency) / HF (High-frequency) ratio, suggesting sympathetic predominance.

Conclusion: Both underweight and overweight status are associated with altered autonomic function, with overweight individuals exhibiting greater autonomic imbalance. Early lifestyle interventions may help restore autonomic equilibrium and reduce future cardiovascular risk.

Keywords: Heart Rate Variability, BMI, Underweight, Overweight, Autonomic Nervous System.

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Introduction

Heart rate variability (HRV) shows the fluctuation in time intervals between consecutive heartbeats and is commonly utilized as a diagnostic of autonomic nervous system function [1]. Reduced HRV has been associated with increased cardiovascular morbidity and mortality [2]. Body mass index (BMI), a simple indication of nutritional health, has a key role in modifying autonomic function [3].

While overweight and obesity have been extensively related to diminished parasympathetic activity and increased sympathetic tone, underweight status is also connected with physiological stress and altered autonomic control [4]. Young individuals constitute an essential demographic for researching these changes, as early autonomic dysfunction may predispose them to long-term cardiovascular repercussions [5]. The purpose of this study was to assess and compare HRV parameters in young people who were overweight and underweight.

Materials and Methods

Study Design and Duration: A one-year from July 2024 to June 2025 observational study carried out at Bhagwan Mahavir Institute of Medical Sciences.

Study Population: 90 young people (18–25 years old) who had regular health evaluations were included.

Inclusion Criteria

- Consenting, healthy pawapuri natives of 18 to 25 years.

Exclusion Criteria

- Known cardiovascular, endocrine, or systemic illness.
- History of smoking, alcohol use, or medication affecting autonomic function.

Grouping

- Participants were categorized based on BMI (WHO criteria):
- Underweight group: BMI < 18.5 kg/m² (n = 45)
- Overweight group: BMI ≥ 25 kg/m² (n = 45)

HRV Analysis

- Five-minute resting ECG recordings were analysed.
- Time-domain parameters: SDNN, RMSSD
- Frequency-domain parameters: LF, HF, LF/HF ratio

Statistical Analysis: Data were presented as mean ± SD. Intergroup comparison was performed using the independent Student's t-test. A p value < 0.05 was considered statistically significant.

Results

Table 1: Baseline Characteristics of Study Participants

Parameter	Underweight (n=45)	Overweight (n=45)
Age (years)	21.5 ± 2.1	22.7 ± 2.3
BMI (kg/m²)	16.6 ± 0.7	27.9 ± 2.2
Resting Heart Rate (bpm)	70 ± 6	76 ± 7

Table 2: Comparison of HRV Parameters Between Groups

HRV Parameter	Underweight	Overweight	p value
SDNN (ms)	44 ± 8	26 ± 8	<0.001
RMSSD (ms)	36 ± 7	28 ± 6	<0.001
LF/HF Ratio	1.3 ± 0.5	2.4 ± 0.6	<0.01

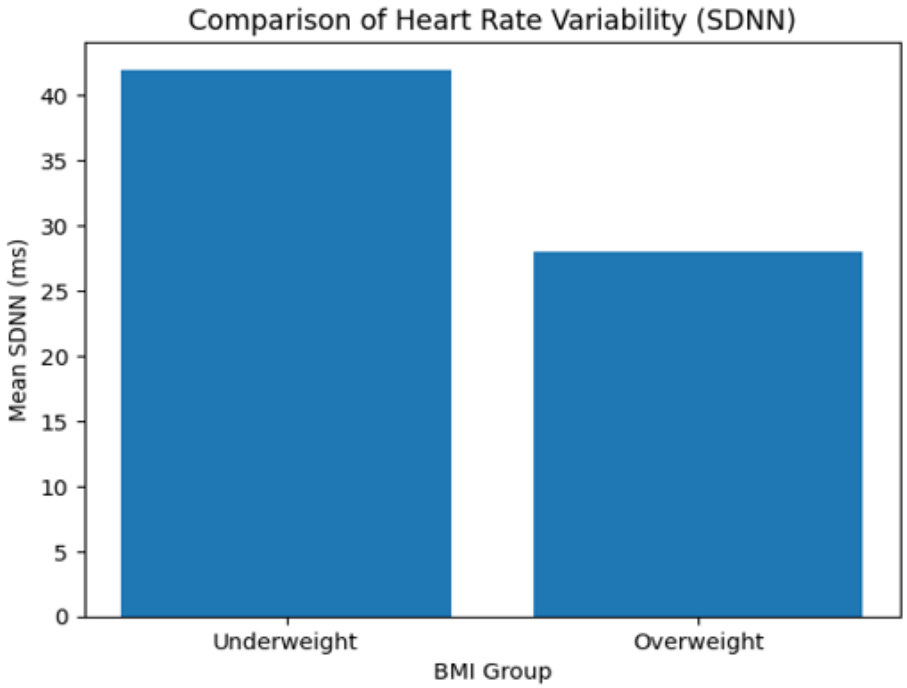

Figure 1: Bar graph showing comparison of mean SDNN values between underweight and overweight individuals.

The above graph unequivocally shows that a higher BMI is linked to a lower heart rate variability, which suggests compromised autonomic regulation. Autonomic function is severely impaired in overweight people, underscoring the significance of early lifestyle modifications.

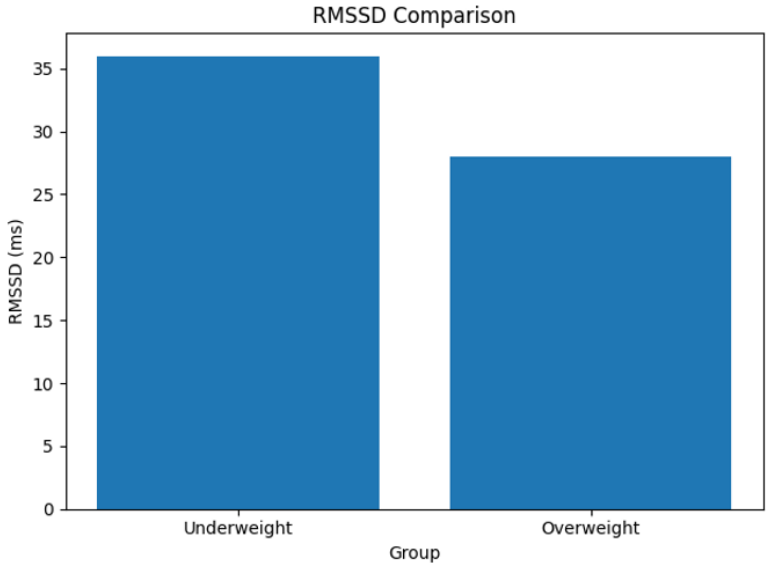

Figure 2: Bar graph showing comparison of mean RMSSD values between underweight and overweight individuals.

The above graph shows underweight people have greater RMSSD values, which are indicative of improved autonomic flexibility and parasympathetic tone. On the other hand, decreased vagal activity and compromised autonomic modulation are suggested by the lower RMSSD in overweight people. Because low RMSSD is linked to increased cardiovascular risk and dysregulation of the stress response, this decrease is clinically significant.

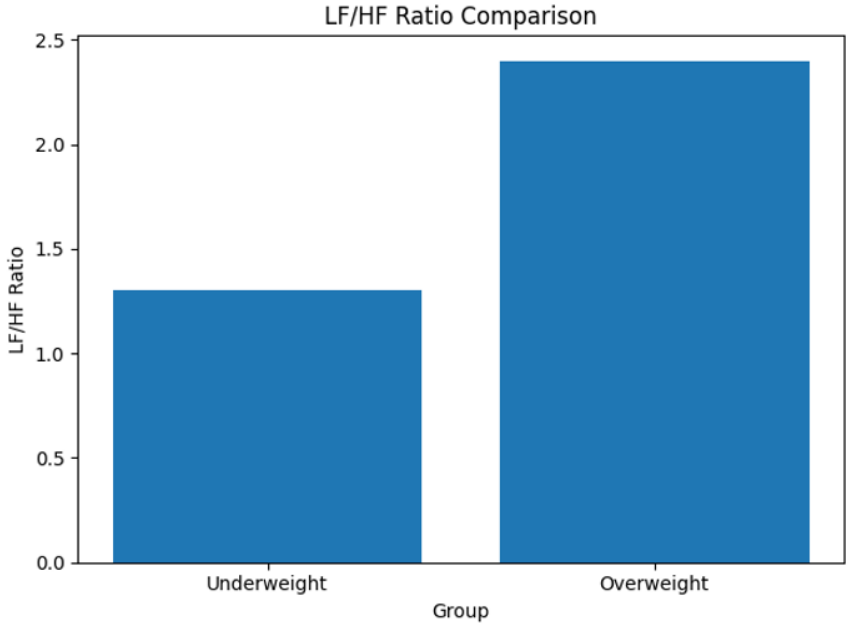

Figure 3: Bar graph showing comparison of mean LF/HF ratio between underweight and overweight individuals.

The above graph shows overweight people have a greater LF/HF ratio, which is indicative of autonomic imbalance and sympathetic dominance. This implies that those who are overweight have a shift in sympathetic activity connected to stress, which may put them at risk for cardiovascular disease, metabolic syndrome, and hypertension. On the other hand, underweight people have lower LF/HF ratio indicates a more balanced autonomic state with a parasympathetic preponderance.

Discussion

The present investigation indicates significant abnormalities in autonomic function in young

individuals at both extremes of BMI. Underweight individuals displayed greater HRV values, implying comparatively intact parasympathetic activation. In contrast, overweight people showed lower HRV and an elevated LF/HF ratio, indicating sympathetic dominance [6].

These results are consistent with earlier research showing stronger sympathetic activity and decreased vagal tone in people with higher BMIs. Even in young, seemingly healthy populations, reduced HRV in overweight people may be an early indicator of cardiovascular risk [7]. Although underweight people displayed superior HRV compared to overweight participants, chronic undernutrition may still predispose them to long-term autonomic instability [8].

Conclusion

This study reveals that BMI considerably effects cardiac autonomic function in young persons. While underweight people exhibit somewhat superior autonomic regulation, overweight people are linked to decreased heart rate variability and sympathetic predominance. HRV measurement may serve as a beneficial early screening technique for diagnosing autonomic dysfunction and guiding preventive actions in young populations.

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