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Original Research Article

Effect of Body Mass Index on ECG P-Wave Dispersion Among Healthy Adults

Jitendra Kumar[1], Sanjay Kumar[2], Manoj Kumar[3], Swati Sinha[4], Sarbil Kumari[5], Amrita Narayan[6]

[123]PG Student, Department of Physiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India

[4]Associate Professor & HOD, Department of Physiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India

[5]Professor, Department of Physiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India

[6]Assistant Professor, Department of Physiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India

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Corresponding Author: Dr. Swati Sinha

Conflict of interest: Nil

Abstract:

Background: P-wave dispersion (PWD) on electrocardiography reveals uneven atrial conduction and is considered a predictor of atrial arrhythmias. Body mass index (BMI) has been found to alter cardiac electrophysiology; nevertheless, its effect on P-wave dispersion in healthy people remains inadequately investigated.

Objective: To evaluate the effect of BMI on ECG P-wave dispersion among healthy adults.

Methods: This observational study was conducted over one year from January 2025 to December 2025 at Bhagwan Mahavir Institute of Medical Sciences and comprised 80 healthy adults aged 20–40 years. According to WHO guidelines, participants were divided into groups with normal and high BMIs. Standard 12-lead ECGs were evaluated to assess maximum P-wave duration (Pmax), minimum P-wave length (Pmin), and P-wave dispersion (PWD = Pmax − Pmin). Statistical comparison between groups was performed using the independent t-test.

Results: Individuals with higher BMI revealed significantly increased Pmax and P-wave dispersion compared to those with normal BMI ($p < 0.05$). A positive connection was observed between BMI and PWD, indicating increasing atrial conduction heterogeneity with growing BMI.

Conclusion: Even in healthy adults, elevated BMI is linked to longer P-wave dispersion, indicating early subclinical atrial electrical remodelling. Monitoring ECG parameters such as PWD may help in early identification of persons at risk for atrial arrhythmias.

Keywords: Body Mass Index, P-wave Dispersion, ECG, Atrial Conduction, Healthy Adults.

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Introduction

There has been a substantial focus in the field of cardiology on exploring the association between body mass index (BMI) and electrocardiographic (ECG) characteristics [1]. The growing concern about obesity and its effects on cardiovascular health is the reason for this attention [2]. There has been an increasing acknowledgement of P-wave dispersion (PWD) as a possible indication for predicting atrial fibrillation. PWD shows promise in this area and is generated from the ECG [3]. This phenomenon, which can shed light on the heterogeneity of atrial conduction, involves variations in the P wave's duration across different ECG leads.

P-wave dispersion (PWD), defined as the difference between the highest and minimum P-wave duration on a typical ECG, reveals inhomogeneous atrial conduction. Increased PWD has been connected with an increased incidence of atrial fibrillation and other supraventricular arrhythmias [4].

BMI is a simple index of weight-for-height that is commonly used to classify underweight, overweight, and obesity in adults and has been associated to structural and electrophysiological alterations in the heart. BMI is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2). Increased BMI is associated with atrial enlargement, decreased autonomic tone, and

inflammatory alterations that may predispose individuals to atrial conduction problems [5].

Although there is ample evidence linking obesity to atrial arrhythmias, little is known about how BMI affects P-wave dispersion in otherwise healthy persons [6]. The present study seeks to examine the effect of BMI on ECG P-wave dispersion among healthy adults.

Materials and Methods

Study Design and Duration: This was an observational study conducted over a period of one year from January 2025 to December 2025 undertaken at Bhagwan Mahavir Institute of Medical Sciences.

Study Population: A total of 80 healthy adults aged 20–40 years who had standard health evaluation were included.

Inclusion Criteria

- Adults aged 20–40 years who were apparently healthy at the time of evaluation.
- Participants with normal sinus rhythm on electrocardiography.
- Individuals categorized based on BMI according to WHO classification.
- Participants who underwent standard 12-lead ECG as part of routine health assessment.
- Individuals who provided informed consent for participation.

Exclusion Criteria

- History of cardiovascular, pulmonary, endocrine, or systemic disease.
- Hypertension, diabetes mellitus, or dyslipidemia.
- Smoking, alcohol intake, or use of drugs affecting cardiac conduction.

BMI Classification

Participants were grouped according to WHO BMI criteria:

- **Normal BMI group:** 18.5–24.9 kg/m² (n = 40)
- **High BMI group:** ≥ 25 kg/m² (n = 40)

ECG Recording and Analysis: Standard 12-lead ECGs were recorded with a calibration of 10 mm/mV and a paper speed of 25 mm/s.

- **Pmax:** Maximum P-wave duration measured across all leads
- **Pmin:** Minimum P-wave duration measured across all leads
- **P-wave dispersion (PWD):** Difference between Pmax and Pmin

Measurements were completed manually using callipers and magnification to minimize inaccuracy.

Statistical Analysis: Data were presented as mean ± standard deviation (SD). Intergroup comparison was done using the independent Student's t-test. Pearson correlation analysis was utilized to analyze the connection between BMI and PWD. A p value < 0.05 was considered statistically significant.

Results

Table 1: Baseline Characteristics of Study Participants

Parameter	Normal BMI (n=40)	High BMI (n=40)
Age (years)	26.4 ± 5.2	27.1 ± 4.5
BMI (kg/m²)	20.3 ± 1.5	28.4 ± 3.4
Heart Rate (bpm)	70 ± 6	78 ± 4

The above table shows both groups are age-matched, the baseline data show that people with greater BMIs had higher resting heart rates, which is indicative of early autonomic dysregulation. This lends credence to the theory that, even in otherwise healthy people, elevated BMI is linked to sympathetic dominance. These baseline variations offer a crucial physiological basis for the study's conclusions that the high BMI group had aberrant atrial conduction and increased P-wave dispersion.

Table 2: Comparison of ECG P-Wave Parameters Between Groups

Parameter	Normal BMI	High BMI	p value
Pmax (ms)	96 ± 10	114 ± 12	< 0.01
Pmin (ms)	62 ± 8	64 ± 10	< 0.05
P-wave Dispersion (ms)	32 ± 8	44 ± 6	< 0.001

The above table shows the findings clearly that those with higher BMI have both larger conduction heterogeneity, as indicated by enhanced P-wave dispersion (PWD), and extended atrial conduction, as indicated by increased Pmax. These alterations point to early atrial tissue electrophysiological reorganization. Overall, the results indicate that elevated BMI is linked to subclinical atrial dysfunction even in seemingly healthy people, which may put them at risk for atrial arrhythmias, especially atrial fibrillation, in the future.

Table 3: Correlation Between BMI and P-Wave Dispersion

Variable	Correlation Coefficient (r)	p value
BMI vs PWD	0.45	< 0.01

The above table shows the hypothesis of early subclinical cardiac remodeling linked to greater BMI is supported by the moderate but significant association between BMI and PWD, which emphasizes the significance of increased body weight as a crucial factor influencing atrial conduction characteristics.

Discussion

The present study reveals that greater BMI is related with considerably higher P-wave dispersion among healthy adults. Individuals with higher BMI had longer Pmax and increased PWD, implying greater atrial conduction heterogeneity [7].

Obesity-related atrial structural remodeling increased atrial size, low-grade inflammation, and altered autonomic balance could all account for the observed connection. These conditions can cause to non-uniform atrial depolarization, hence increasing P-wave dispersion [8]. The results are in line with other research that found a link between atrial arrhythmogenesis and elevated PWD in overweight and obese people. Crucially, the current work emphasizes the subclinical effect of elevated BMI on cardiac electrophysiology by showing that such alterations can be seen even in asymptomatic, otherwise healthy persons [9].

Conclusion

This observational study reveals that higher BMI is strongly linked with increased ECG P-wave dispersion among healthy persons. These findings imply early atrial electrical remodeling with rising BMI, potentially predisposing individuals to subsequent atrial arrhythmias. Routine ECG measurement of P-wave characteristics may serve as a simple and non-invasive method for early risk classification in persons with elevated BMI.

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