



ASSOCIATION BETWEEN BODY MASS INDEX AND BLOOD PRESSURE IN YOUNG ADULTS

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Abstract

Background: Obesity is an established risk factor for hypertension and cardiovascular disease. Increasing body mass index (BMI) among young adults may contribute to early elevation of blood pressure, predisposing individuals to long-term cardiovascular complications. **Aim:** To evaluate the association between body mass index and blood pressure and to determine the prevalence of overweight, obesity, and hypertension among young adults. **Methods:** A cross-sectional study was conducted among 262 young adults aged 18–26 years, including 131 males and 131 females. Anthropometric measurements including height and weight were recorded, and BMI was calculated. Blood pressure parameters including systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were measured using standard procedures. BMI categories and blood pressure classifications were determined according to standard criteria. Correlation and linear regression analyses were performed to assess the association between BMI and blood pressure. **Results:** The mean age of participants was 21.88 ± 2.53 years. Males had significantly higher mean BMI (24.15 ± 2.80 kg/m²) compared to females (22.61 ± 8.15 kg/m²; $p = 0.010$). Mean SBP and DBP were significantly higher in males (123.20 ± 9.19 mmHg and 79.21 ± 5.89 mmHg) compared to females (116.21 ± 8.29 mmHg and 74.53 ± 5.47 mmHg; $p < 0.001$). The overall prevalence of overweight and obesity was 25.2%, while 7.58% of participants were hypertensive. BMI showed a significant positive correlation with SBP ($r = 0.45$, $p < 0.001$) and DBP ($r = 0.40$, $p < 0.001$). Gender-wise analysis demonstrated stronger correlations in males (SBP $r = 0.705$; DBP $r = 0.719$; $p < 0.001$) compared to females (SBP $r = 0.176$; DBP $r = 0.178$; $p < 0.05$). Linear regression analysis indicated that for every 1 kg/m² increase in BMI, SBP increased by 1.2 mmHg and DBP increased by 0.8 mmHg ($p < 0.001$). **Conclusion:** BMI is significantly associated with elevated blood pressure among young adults, with stronger effects observed in males. A considerable proportion of participants were overweight or hypertensive, indicating early cardiovascular risk. Early identification and lifestyle interventions targeting weight management may help reduce future hypertension burden in this population.

Keywords: body mass index; blood pressure; hypertension; young adults; overweight; obesity; cardiovascular risk; systolic blood pressure; diastolic blood pressure.

INTRODUCTION

Hypertension is a major global public health concern and one of the leading modifiable risk factors for cardiovascular morbidity and mortality. It is defined as a sustained elevation of arterial blood pressure $\geq 140/90$ mmHg in adults and is classified as either primary (essential) or secondary hypertension. Essential hypertension accounts for nearly 90–95% of cases and results from complex interactions between genetic, environmental, and lifestyle factors.¹

Globally, hypertension contributes substantially to ischemic heart disease, stroke, heart failure, and chronic kidney disease. The burden of hypertension has shown a rising trend in low- and middle-income countries due to urbanization, dietary transition, sedentary lifestyle, and increasing obesity rates.²

Although traditionally considered a disorder of middle-aged and elderly individuals, hypertension is increasingly being detected in young adults. Early elevation of blood pressure significantly increases the lifetime risk of cardiovascular disease. Studies have demonstrated that elevated blood pressure during adolescence and early adulthood tracks into later life and predisposes individuals to premature atherosclerosis.³

Body mass index (BMI) is a simple and widely used anthropometric measure to classify individuals as underweight, normal weight, overweight, or obese. Overweight and obesity are strongly associated with elevated blood pressure. Several epidemiological studies have shown a positive correlation between BMI and both systolic and diastolic blood pressure.⁴

The pathophysiological mechanisms linking obesity and hypertension include activation of the sympathetic nervous system, stimulation of the renin-angiotensin-aldosterone system, insulin resistance, endothelial dysfunction, and increased inflammatory mediators.⁵

In India, the prevalence of overweight and obesity among young adults has increased significantly over the past two decades. Parallel to this rise, early-onset hypertension is also becoming more common. University students represent a vulnerable population due to sedentary habits, irregular diet patterns, academic stress, and reduced physical activity.⁶

Early identification of elevated blood pressure and its association with BMI in young adults is essential for implementing preventive strategies and reducing future cardiovascular risk. Therefore, this study aims to evaluate the correlation between body mass index and blood pressure among young adults.

AIM AND OBJECTIVES

Aim

To evaluate the association between Body Mass Index (BMI) and blood pressure among young adults.

Objectives

1. To determine the prevalence of overweight and obesity among young adults.
2. To assess the prevalence of hypertension among young adults.
3. To evaluate the correlation between BMI and systolic and diastolic blood pressure.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional study was conducted in the Department of Physiology, Government Medical College and Associated Hospitals, Jammu.

Study Period

The study was carried out over a period of one year from 1st April 2024 to 31st March 2025.

Study Population and Sample Size

A total of 256 healthy young adults of both sexes, aged 18–26 years, were recruited from different colleges in the Jammu region.

Ethical Approval

The study was approved by the Institutional Ethics Committee (IEC/GMCJ/2024/1857 dated 07/06/2024). Written informed consent was obtained from all participants in accordance with the principles of the Declaration of Helsinki.

Inclusion Criteria

- * Age between 18–26 years
- * Both males and females
- * Provided written informed consent

Exclusion Criteria

- * Family history of hypertension
- * History of chronic diseases such as diabetes mellitus, cancer, heart failure, renal failure, liver disease, HIV/AIDS, or hematological disorders
- * Seriously ill individuals

Data Collection Procedure

Anthropometric and blood pressure measurements were obtained after written informed consent.

Anthropometric Measurements

Body weight was measured using a calibrated electronic weighing scale to the nearest 0.5 kg with participants barefoot and wearing minimal clothing.

Height was measured using a stadiometer to the nearest 0.5 cm with participants standing erect, barefoot, with shoulders relaxed and arms hanging freely.

Body Mass Index (BMI) was calculated using the Quetelet index:

$$\text{BMI} = (\text{weight}/\text{height})^2$$

BMI was categorized according to WHO criteria as:

- * $<18.5 \text{ kg/m}^2$ – Underweight
- * $18.5\text{--}24.9 \text{ kg/m}^2$ – Normal
- * $25\text{--}29.9 \text{ kg/m}^2$ – Overweight
- * $\geq 30 \text{ kg/m}^2$ – Obese

Blood Pressure Measurement

Radial pulse rate (beats/min) was recorded for one full minute using the palpatory method.

Blood pressure was measured using a calibrated manual mercury sphygmomanometer (2 mm Hg divisions) by the auscultatory method. Participants were allowed to rest for 5 minutes before measurement.

The procedure included:

- * Inflation of cuff to occlude the brachial artery
- * Gradual deflation with auscultation over the brachial artery
- * First Korotkoff sound recorded as systolic blood pressure (SBP)
- * Disappearance of sound recorded as diastolic blood pressure (DBP)

Three readings were taken and the mean value was considered for analysis.

Mean arterial pressure (MAP) was calculated as:

$$\text{MAP} = \text{DBP} + 1/3(\text{SBP} - \text{DBP})$$

Blood pressure was classified according to Joint National Committee (JNC VI) criteria:

Category	SBP (mmHg)	DBP (mmHg)
Normal	<120	<80
Pre-hypertension	120–139	80–89
Stage 1 Hypertension	140–159	90–99
Stage 2 Hypertension	≥ 160	≥ 100

Statistical Analysis

Data were collected using a predesigned proforma including demographic details, clinical history, physical examination findings, anthropometric measurements, and blood pressure recordings. Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0.

* Quantitative variables were expressed as mean $\pm$ standard deviation (SD).

* Qualitative variables were expressed as frequency and percentage.

* Independent t-test and chi-square test (χ^2) were used for comparison.

* Correlation between BMI and SBP/DBP was evaluated.

* A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

A total of 262 young adults (131 males and 131 females) aged 18–26 years were included in the study.

The mean age of participants was comparable between males and females (21.86 ± 2.54 vs 21.89 ± 2.53 years; $p = 0.983$). However, significant gender differences were observed in height, weight, BMI, and blood pressure parameters ($p < 0.05$).

Table 1: Demographic and Clinical Characteristics of Study Participants

Parameter	Total	Males (n=131)	Females (n=131)	p-value
Age (years)	21.88 ± 2.53	21.86 ± 2.54	21.89 ± 2.53	0.983
Height (cm)	168.39 ± 5.99	172.70 ± 4.38	164.14 ± 3.98	<0.001
Weight (kg)	65.14 ± 10.87	72.03 ± 8.43	58.35 ± 8.47	<0.001
BMI (kg/m^2)	23.37 ± 6.15	24.15 ± 2.80	22.61 ± 8.15	0.010

BMI distribution differed significantly between males and females ($p = 0.0105$). A higher proportion of males were overweight, whereas females had a higher prevalence of underweight and obesity. The overall prevalence of overweight/obesity was 25.2%, with higher prevalence among males (29.77%) compared to females (20.61%).

Table 2: Distribution of BMI Categories Among Study Participants

BMI Category	Total (N=262)	Males (n=131)	Females (n=131)	p-value
Underweight (<18.5)	11 (4.17%)	1 (0.76%)	10 (7.63%)	
Normal (18.5–24.9)	187 (70.83%)	91 (69.4%)	96 (73.28%)	
Overweight (25–29.9)	54 (20.45%)	34 (25.9%)	20 (15.26%)	
Obese (≥ 30)	12 (4.55%)	5 (3.81%)	7 (5.34%)	0.0105

Significant gender differences were observed in systolic and diastolic blood pressure distribution ($p < 0.001$). Males demonstrated higher proportions in pre-hypertensive and hypertensive categories. Overall prevalence of hypertension (Stage 1 and Stage 2) was 7.58%, with higher prevalence in males (9.92%) compared to females (5.34%).

Table 3: Distribution of Systolic and Diastolic Blood Pressure Categories

Category	Total	Males	Females	p-value
Systolic Blood Pressure				<0.001
<120 mmHg	160 (61.07%)	60 (45.8%)	100 (76.3%)	
120–139 mmHg	83 (31.68%)	59 (45.03%)	24 (18.32%)	
140–159 mmHg	19 (7.25%)	12 (9.16%)	7 (5.34%)	
Diastolic Blood Pressure				<0.001
<80 mmHg	199 (75.95%)	82 (62.6%)	117 (89.3%)	
80–89 mmHg	46 (17.56%)	38 (29%)	8 (6.10%)	
90–99 mmHg	17 (6.49%)	11 (8.39%)	6 (4.58%)	

BMI showed a statistically significant moderate positive correlation with both systolic and diastolic blood pressure ($p < 0.001$). Gender-wise analysis demonstrated stronger correlations among males (SBP $r = 0.705$; DBP $r = 0.719$; $p < 0.001$) compared to females (SBP $r = 0.176$; DBP $r = 0.178$; $p < 0.05$).

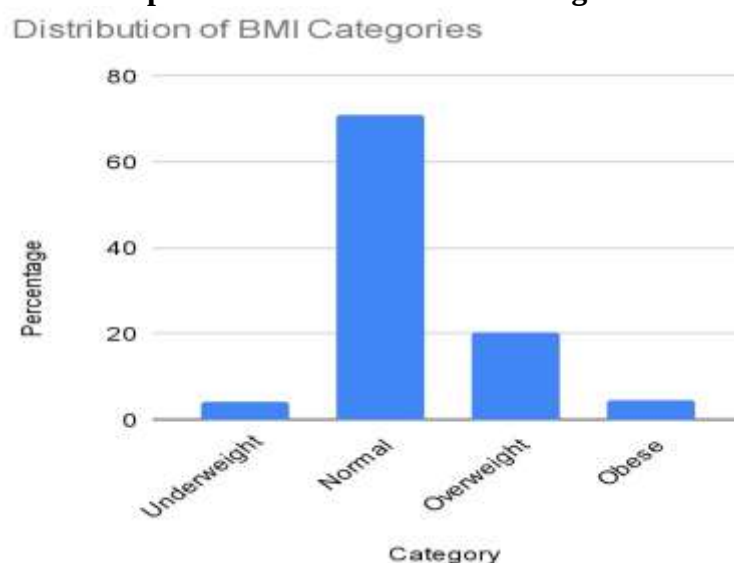
Table 4: Correlation Between BMI and Blood Pressure

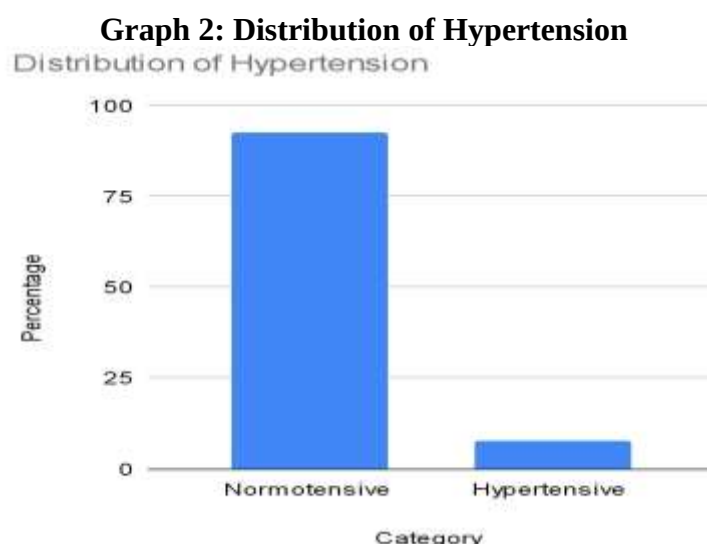
Analysis	SBP (r)	p-value	DBP (r)	p-value
Pearson's Correlation	0.45	<0.001	0.40	<0.001
Spearman's Correlation	0.43	<0.001	0.38	<0.001

Linear regression analysis demonstrated that BMI was a significant predictor of both systolic and diastolic blood pressure.

Table 5: Linear Regression Analysis Showing BMI as Predictor of Blood Pressure

Dependent Variable	Regression Coefficient (β)	p-value
SBP	1.2	<0.001
DBP	0.8	<0.001

Graph 1: Distribution of BMI Categories.



DISCUSSION

The present cross-sectional study evaluated the association between body mass index (BMI) and blood pressure (BP) and determined the prevalence of overweight/obesity and hypertension among young adults. The findings demonstrate a significant positive relationship between BMI and both systolic and diastolic blood pressure, with notable gender differences in distribution and strength of association.

Our study demonstrated a moderate positive correlation between BMI and systolic blood pressure ($r = 0.45$) and diastolic blood pressure ($r = 0.40$), both statistically significant ($p < 0.001$). Linear regression analysis further confirmed BMI as a significant predictor of SBP and DBP. These findings are consistent with previous epidemiological studies that have established BMI as an independent determinant of blood pressure [7,8,9].

He et al. Demonstrated that blood pressure is positively associated with BMI across both normal and obese individuals [7]. Similarly, Hossain et al. Reported a strong association between BMI and hypertension in South Asian populations, emphasizing the growing burden in developing countries [8]. Kawabe et al. Further highlighted that obesity plays a central role in early-onset hypertension among young adults [9].

The pathophysiological basis of this relationship is well documented. Obesity contributes to hypertension through activation of the renin–angiotensin–aldosterone system, sympathetic overactivity, renal compression, sodium retention, and endothelial dysfunction [10,11]. Adipose tissue–derived inflammatory cytokines and insulin resistance further increase vascular stiffness and peripheral resistance, leading to elevated blood pressure [10].

Although age distribution was comparable between males and females, significant differences were observed in height, weight, BMI, and blood pressure. Males exhibited higher mean height and weight values, which can be attributed to hormonal influences such as testosterone-mediated muscle mass development [12]. Earlier epiphyseal closure in females due to estrogen exposure explains the shorter stature observed in women [13].

These physiological differences translated into higher BMI and blood pressure levels among males. Similar gender disparities have been reported in previous studies examining body composition and cardiovascular risk [14].

The overall prevalence of overweight/obesity in our cohort was 25.2%, with higher prevalence among males (29.77%) compared to females (20.61%). This finding aligns with global data showing increasing trends in obesity among young adults [15].

NCD-RisC Collaboration recently reported a marked rise in overweight and obesity across low- and middle-income countries, including South Asia [15]. Ni Mhurchu et al. Also demonstrated a strong relationship between BMI and cardiovascular risk in Asia-Pacific populations [16]. Similar findings have been reported in Indian young adult populations, highlighting obesity as a major modifiable cardiovascular risk factor [17].

In our study, males demonstrated significantly higher SBP and DBP values compared to females ($p < 0.001$). Approximately 7.58% of participants were hypertensive, with higher prevalence among males (9.92%) compared to females (5.34%).

Sex differences in blood pressure regulation are well established. Estrogen exerts vasodilatory and endothelial protective effects, whereas males exhibit higher sympathetic activity and peripheral vascular resistance [18]. Hart et al. Demonstrated significant sex differences in sympathetic neural control of blood pressure, explaining higher BP levels in males [18].

Our hypertension prevalence is slightly lower than that reported in some Indian studies [19], possibly due to regional, lifestyle, and demographic variations. However, the gender trend observed in our study is consistent with Pisa et al., who reported higher hypertension prevalence among males [20].

Mean arterial pressure was significantly higher in males compared to females. Similar hemodynamic findings were reported by Kaypakli and Ozgeyik, who demonstrated variability in MAP values depending on heart rate and vascular resistance patterns [21].

Pulse rate did not significantly differ between genders in our cohort, suggesting that BMI influences blood pressure predominantly through vascular and metabolic mechanisms rather than direct chronotropic effects.

A key observation of our study was the stronger correlation between BMI and blood pressure among males ($r > 0.70$) compared to females ($r \approx 0.17$). This difference may be explained by variations in fat distribution patterns. Males tend to accumulate visceral adiposity, which is metabolically active and strongly linked to sympathetic activation and RAAS stimulation [10]. Females typically store fat subcutaneously, which has relatively lower cardiovascular risk implications.

Similar sex-based differences in BMI–BP association have been reported by Khalid et al. And Koh et al., who observed stronger associations in males compared to females [22,23].

The rising prevalence of overweight/obesity and its significant association with blood pressure among young adults underscores the urgent need for early screening and preventive strategies. Lifestyle modification programs targeting weight reduction, physical activity, and dietary regulation could substantially reduce future cardiovascular morbidity.

Our findings reinforce the concept that BMI is not merely an anthropometric index but a clinically meaningful predictor of cardiovascular risk in young populations.

CONCLUSION

The present study demonstrates a statistically significant positive association between body mass index (BMI) and both systolic and diastolic blood pressure among young adults. As BMI increased, blood pressure levels rose correspondingly, confirming excess body weight as an important determinant of elevated blood pressure in this population.

The overall prevalence of overweight and obesity was considerable, affecting approximately one-fourth of participants, while a measurable proportion of young adults were already hypertensive. Males exhibited significantly higher BMI and blood pressure values compared to females, along with a stronger correlation between BMI and blood pressure, suggesting possible gender-based physiological differences in cardiovascular risk profiles.

These findings indicate that even in early adulthood, increased adiposity is associated with adverse hemodynamic changes. The presence of elevated blood pressure in this age group highlights the early onset of cardiovascular risk and underscores the importance of routine screening.

From a public health perspective, BMI serves as a simple, non-invasive, and cost-effective marker for identifying individuals at risk of developing hypertension. Early lifestyle interventions—including weight management, dietary modification, and increased physical activity—may substantially reduce the long-term burden of cardiovascular disease.

In conclusion, the study reinforces the role of increased body mass index as a significant predictor of elevated blood pressure among young adults and emphasizes the need for early preventive strategies to mitigate future cardiovascular morbidity.

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