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Association between Blood Pressure and Body Composition Indices among the Kisan of Malda, West Bengal, India

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Abstract: In the world of health studies, investigations of blood pressure (BP) have been shown to be a prominent marker. Several body compositional indicators and lifestyle disorders play a significant role in determining BP. This cross-sectional study included 377 adult Kisan participants (including both male and female) from Malda, West Bengal. Descriptive and inferential statistics were calculated using SPSS version 27.0. *Results:* Most participants were hypertensive, which is a concern. The data revealed that the mean body composition in the normotensive category was the lowest and gradually increased in each MAP category. In males, VF ($r = 0.338$, $p < 0.01$) and %BF ($r = 0.333$, $p < 0.01$), whereas in females, age ($r = 0.390$, $p < 0.01$), VF ($r = 0.383$, $p < 0.01$) and %BF ($r = 0.350$, $p < 0.01$) exhibited the strongest correlation with MAP. Stepwise linear regression depicted age % BF and BSA as the best predictors of MAP for combined sexes, which significantly explained 19.1% of the variance in MAP. Overall, the results demonstrated sex-specific differences in MAP predictors. It is comprehensible from the aforementioned findings that anthropometric factors are positively correlated with the MAP categories. Moreover, sex-specific differences were observed. It is obvious that, if desired, a unit of a particular change in the relevant body composition variables can lower BP to a given level.

Keywords: Adiposity, Body Composition, Blood Pressure, BSA, MAP, Fat percentage.

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Introduction

Blood pressure is a crucial health indicator responsible for global morbidity and mortality. Escalated blood pressure is often associated with cardiovascular diseases. According to the WHO fact sheet (2012-2013), Blood Pressure alone represents more than 10% of the death rate by acting as an underlying base for Non-Communicable Diseases (NCDs). Blood Pressure is influenced by complex physiological and environmental factors, including body composition. Body composition and its association with different health perspectives have been the subject of scholarly interest for the last few decades. Several studies have conveyed that body composition plays a crucial role in understanding the bodily parameters (Al-Sendi et al., 2003; Mungreiphy et al., 2011; Gajalakshmi et al., 2018; Li et al., 2018; Yüksel et al., 2021; Dahel-Mekhancha et al., 2022). Obesity and other body composition parameters contribute significantly to the hypertension risk (Wang et al., 2019). However, the nature of this relationship can vary across populations owing to genetic, dietary, and lifestyle differences (Sun et al., 2019). Hence, understanding this association among specific ethnic groups is essential for developing targeted health interventions, particularly in India, which is known for its ethnic diversity.

Body composition includes various indices, including the body mass index (BMI), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), body fat percentage (%BF), lean mass, etc. Moreover, different types of health associations have been reported in the literature. Studies have manifested that excess adiposity, particularly visceral fat (VF), plays a crucial role in elevating blood pressure by increasing insulin resistance, systemic inflammation, and vascular dysfunction (Hall et al., 2015). Even though BMI is typically utilised to measure obesity, it may not precisely speculate fat distribution, necessitating a comprehensive assessment using multiple body composition indices (Hu et al., 2020). Identifying the best predictor of blood pressure among these indices remains a significant research question, particularly in underrepresented populations such as the Kisans of Malda.

The Kisan community (currently facing an identity crisis; this community claims to be the Kisan Tribe, but the Government recognises them as the General Hindu Caste), an ethnic group residing in Malda, India, has unique socio-cultural and dietary practices that may influence body composition and cardiovascular health. Despite the growing burden of NCDs in rural

India, limited research has concentrated on the relationship between body composition and blood pressure (Patel et al., 2016). Gupta and Ram (2019) emphasised the need for population-specific health assessments, as generic health models may not adequately capture variations in disease risk across different ethnicities.

Objectives

The objectives of this research are-

- to examine the relationship between body composition indices and blood pressure in the Kisan community of Malda, India; and
- to identify the most significant body composition predictor of blood pressure in this ethnicity.

Materials and Methods

Study population & Sampling

This study was conducted among Kisan participants from Bhutni Island, Malda district of the Indian state of West Bengal, between March 2022 and September 2022. Only adults were included in the study. The Fisher formula was employed to calculate the sample size: $n=Z^2 pq/d^2$ ($z=1.96$, $p=0.38$, $q=1-p$, $d=0.5$). The sample size was 273, and after adding 10% for sample loss and outliers, it became 301 as the base sample. For this particular study, 377 participants (173 male & 204 female) were considered. Data were gathered from participants using standardised approaches and methods. A simple random sampling approach was employed to draw the sample.

Inclusion & Exclusion Criteria

The selection criteria were: (i) the age of participants spanned from 18 to 60 years, and (ii) they were free from any physical deformities and diseases. The criteria for exclusion were as follows: (i) use of any hormonal therapy or drugs (antihypertensive, diabetic, etc.) and (ii) pregnancy or recent delivery outcomes (<6 months).

Ethical Considerations

The Institutional Ethical Committee (IEC) of West Bengal State University, IEC Approval No. WBSU/IEC/30/03, dated 07.10.2021, approved for conducting

the study after explaining the objectives of the study. Written consent was taken from all participants. As part of the ethical considerations, special care was taken to avoid any kind of physical or mental harm caused by the study.

Measurement of Variables

Data were collected using a predesigned schedule. For the assessment of height, MUAC, HC, and WC anthropometric rod and a non-elastic measuring tape were used. An automatic Bioelectrical Impedance Analyser (Omron HBF 375, Japan) was used to measure and calculate body weight, BMI and other body composition variables. Data were collected by the same researcher and with the same instruments. Height, MUAC, WC, HC, and weight were recorded precise to 0.1 cm and 0.1 kg, respectively (Lohman et al., 1988). During the measurements, the participants were requested to put on loose-fitting, minimal, light clothes and to be barefoot. Weight, BMI, and body composition were calculated automatically using the Karada scan. BMI was rechecked using a standard formula. An aneroid sphygmomanometer with a relevant cuff size was employed to determine blood pressure. The participants were instructed to sit comfortably in a chair with their arms resting, and measurements were taken on the right arm using standardised methods. In addition, the measurement was repeated twice with a ten-minute interval for accuracy.

The Formula used for the Selected Variables

BMI= weight in kg/ height in m^2 (cut off: BMI < 18.5 is underweight, 18.5 - 24.9 is normal weight, 25 - 29.9 is overweight, and ≥ 30 is obesity)

WHR= waist in cm/ hip in cm (cut off: Women, ≤ 0.80 is low risk, 0.81 - 0.85 is moderate risk, ≥ 0.86 is high risk; Men, ≤ 0.95 is low risk, 0.96 – 1.0 is moderate risk, ≥ 1.0 is high risk)

WHtR= waist in cm/ height in cm (cut off: Women ≤ 0.34 is extremely slim, 0.35 - 0.41 is slim, 0.42 – 0.48 is healthy, 0.49 – 0.53 is overweight, 0.54 – 0.57 is very overweight, ≥ 0.58 is obese; Men ≤ 0.34 is extremely slim, 0.35 - 0.42 is slim, 0.43 – 0.52 is healthy, 0.53 – 0.57 is overweight, 0.58 - 0.62 is very overweight, ≥ 0.63 is obese)

BSA= square root of ([Height (cm) x Weight (kg)]/ 3600) (Mosteller's formula)

MAP= DBP + 1/3 (SBP – DBP) (cut off: < 90 mmHg is Normotensive, 90 - < 92 mmHg is Elevated, 92 - < 96 mmHg is age 1 Hypertension, > 96 mmHg is age 2 Hypertension)

Statistical Analysis

SPSS (Statistical Package for Social Sciences), version 27.0, were utilised for data analysis. Moreover, the data were double-checked prior to their processing. After performing the normality test, the data were tabulated to represent the descriptive statistics with mean, standard error, etc., for combined sexes. Spearman's correlation has been applied to check the association between the body composition variables and MAP categories. To check the relationship of the variables and blood pressure, ANOVA, chi-square, and stepwise linear regressions were performed.

Results

Table 1 presents the mean Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Mean Arterial Pressure (MAP) for the participants. No significant differences were observed in these blood pressure components between males and females.

Table 1: Sex-based Comparison of Blood Pressure Parameters

	Sex	*Mean ± SE*	*t-value*	*p value*
SBP	Male	137.50 ± 1.66	1.671	0.146
	Female	133.59 ± 1.63		
DBP	Male	82.80 ± 1.08	1.916	0.208
	Female	80.13 ± 0.89		
MAP	Male	101.03 ± 1.21	1.897	0.958
	Female	97.95 ± 1.09		

Table 2 provides a comprehensive breakdown of age and body composition variables across the four Mean Arterial Pressure (MAP) categories. The data revealed that the mean weight in the normotensive category was the lowest, with a mean of 51.89 ± 1.36 kg for males and 44.34 ± 0.92 kg for females. In contrast, the weight gradually increased in the stage 2 hypertension group, with mean values of 58.02 ± 0.83 kg and 50.72 ± 0.85 kg for males and females, respectively. This upward trend was observed

across almost all measured body composition variables, indicating a clear association between elevated blood pressure and increased body composition index. Notably, the data for both sexes demonstrated a discernible pattern, underscoring the association with higher blood pressure categories and corresponding increases in body composition parameters. ANOVA was conducted to assess the variations in selected anthropometric parameters throughout the four metabolic abnormality phenotype (MAP) categories for both male and female participants. For males, the analysis revealed statistically significant differences among the groups in the following variables: weight ($F = 5.624$, $p = 0.001$), BMI ($F = 4.947$, $p = 0.003$), body fat ($F = 4.865$, $p = 0.003$), visceral fat ($F = 3.052$, $p = 0.030$), WHtR ($F = 4.833$, $p = 0.003$), and BSA ($F = 4.947$, $p = 0.003$). Whereas for females, the analysis indicated statistically significant differences across the MAP categories for age ($F = 9.675$, $p < 0.001$), weight ($F = 8.664$, $p < 0.001$), BMI ($F = 10.017$, $p < 0.001$), body fat ($F = 10.054$, $p < 0.001$), visceral fat ($F = 8.021$, $p < 0.001$), WHtR ($F = 9.793$, $p < 0.001$), WHR ($F = 8.589$, $p < 0.001$), and BSA ($F = 7.412$, $p < 0.001$). The differences in body composition variables across the MAP categories were more pronounced in females than in males, suggesting a potentially greater variation in metabolic risk factors within the female cohort.

Table 2: Body Composition Variables as per MAP Category

Variables	*Sex*	*Mean ± SE*				*F value*	*p value*
		Normotensive (n= 112)	*Elevated (n = 18)*	*Stage 1 hypertension (n = 37)*	*Stage 2 hypertension (n = 210)*		
Age (in years)	**M**	39.76 ± 1.70	36.20 ± 2.87	40.94 ± 2.19	43.19 ± 1.14	**1.883**	**0.134**
	F	36.10 ± 1.31	40.13 ± 4.01	41.85 ± 2.01	44.04 ± 0.83	**9.675**	**0.000**
Height (cm)	**M**	159.17 ± 0.84	159.40 ± 1.67	160.54 ± 1.36	159.51 ± 0.58	**0.244**	**0.865**
	F	147.04 ± 0.62	147.33 ± 2.66	146.58 ± 1.06	147.35 ± 0.54	**0.135**	**0.939**
Weight (kg)	**M**	51.89 ± 1.36	53.55 ± 1.40	58.00 ± 2.43	58.02 ± 0.83	**5.624**	**0.001**
	F	44.34 ± 0.92	45.13 ± 2.91	49.42 ± 1.99	50.72 ± 0.85	**8.664**	**0.000**
BMI (kg/m^2)	**M**	20.48 ± 0.49	21.14 ± 0.69	22.44 ± 0.80	22.64 ± 0.31	**4.947**	**0.003**
	F	20.57 ± 0.41	20.68 ± 0.99	23.01 ± 0.89	23.42 ± 0.35	**10.017**	**0.000**
% BF (%)	**M**	22.72 ± 1.09	22.10 ± 2.48	26.12 ± 2.18	27.19 ± 0.64	**4.865**	**0.003**
	F	31.69 ± 0.89	34.66 ± 1.69	36.23 ± 1.06	36.54 ± 0.46	**10.054**	**0.000**
Visceral fat (%)	**M**	6.36 ± 1.04	5.30 ± 0.59	7.72 ± 0.97	8.62 ± 0.42	**3.052**	**0.030**
	F	4.15 ± 0.43	4.06 ± 0.84	6.08 ± 0.85	6.66 ± 0.33	**8.021**	**0.000**

Variables	*Sex*	*Mean ± SE*				*F value*	*p value*
		Normotensive (n= 112)	*Elevated (n = 18)*	*Stage 1 hypertension (n = 37)*	*Stage 2 hypertension (n = 210)*		
WHtR	**M**	0.48 ± 0.01	0.49 ± 0.02	0.50 ± 0.02	0.51 ± 0.00	**4.833**	**0.003**
	F	0.49 ± 0.01	0.48 ± 0.02	0.54 ± 0.02	0.55 ± 0.00	**9.793**	**0.000**
WHR	**M**	0.90 ± 0.01	0.91 ± 0.01	0.92 ± 0.02	1.02 ± 0.08	**0.416**	**0.741**
	F	0.83 ± 0.01	0.81 ± 0.02	0.86 ± 0.01	0.88 ± 0.00	**8.589**	**0.000**
BSA (m^2)	**M**	1.51 ± 0.02	1.54 ± 0.02	1.60 ± 0.04	1.59 ± 0.01	**4.808**	**0.003**
	F	1.34 ± 0.02	1.36 ± 0.05	1.41 ± 0.03	1.44 ± 0.01	**7.412**	0.000

Table 3 exhibits the distribution of the studied population according to different body composition categories. A significant proportion of the participants, approximately 59.5% of the males and 52% females, exhibited Stage 2 hypertension. The male population displayed a higher hypertensive tendency than their female counterparts, yet the difference was not significant from a statistical standpoint. For BMI categories, the sample painted a completely different picture, where the majority of the participants were categorised as normal weight (67.6% male and 58.3% female participants). Only a few individuals were obese. With respect to WHR categories, a significant proportion of males were at low risk, which reflects the same situation as depicted in the BMI category. However, in the case of female the picture turned out to be contrasting, and 45.1% of females were at high risk. According to the WHtR, most males were categorised as healthy, but females represented all categories with similar frequencies. The chi-square statistics depicted significant sex disparities in the WHR and WHtR categories in this population.

Spearman's correlation between body composition and MAP for both sexes is shown in Table 4 and Figure 1. Positive correlations were observed across multiple parameters, indicating that body composition plays a crucial role in influencing blood pressure. In males, VF (r = 0.338, p < 0.01) and %BF (r = 0.333, p < 0.01) exhibited the strongest correlations with MAP. This probably indicates that central adiposity may be a more influential determinant of blood pressure in males in this population. Notably, age (r = 0.390, p < 0.01) depicted the strongest correlation with MAP in females, followed by VF (r = 0.383, p < 0.01) and %BF (r = 0.350,

Table 3: Distribution of the Studied Population as per Body Composition Categories

	MAP Category					
SEX	*Normotensive*	*Elevated*	*Stage 1 Hypertension*	*Stage 2 Hypertension*	χ^2	*P VALUE*
MALE	42 (24.3%)	10 (5.8%)	18 (10.4%)	103 (59.5%)	4.854 df= 3	0.183
FEMALE	70 (34.3%)	8 (3.9%)	20 (9.8%)	106 (52.0%)		
	BMI Category					
	Underweight	Normal	Overweight	Obese		
MALE	21 (12.1%)	117 (67.6%)	34 (19.7%)	1 (0.6%)	5.638 df=3	0.130
FEMALE	37 (18.1%)	119 (58.3%)	43 (21.1%)	5 (2.5%)		
	WHR Category					
	Low Risk	Moderate Risk		High Risk		
MALE	129 (74.6%)	23 (13.3%)		21 (12.1%)	76.339 df=2	<0.0001
FEMALE	58 (28.4%)	42 (26.5%)		92 (45.1%)		

	WHtR Category						
	Slim	*Healthy*	*Overweight*	*Very overweight*	*Obese*		
MALE	18 (10.4%)	97 (56.1%)	47 (27.2%)	11 (6.4%)	0 (0.0%)	**72.079** ***df=3***	**<0.0001**
FEMALE	15 (7.4%)	47 (23.0%)	59 (28.9%)	38 (18.6%)	45 (22.1%)		

$p < 0.01$), revealing that both ageing and adiposity are critical factors influencing blood pressure in this group. In the comparison between sexes, the correlation coefficients for most variables were higher in females than in males, suggesting that body composition has a more pronounced impact on MAP in females.

Table 4: Spearman Correlation between Body Composition and MAP

		AGE	*BMI*	*%BF*	*VF*	*WHTR*	*WHR*	*BSA*
MAP	M	0.244**	0.289**	0.333**	0.338**	0.261**	0.197**	0.296**
	F	0.390**	0.346**	0.350**	0.383**	0.343**	0.312**	0.320**

** p<0.01

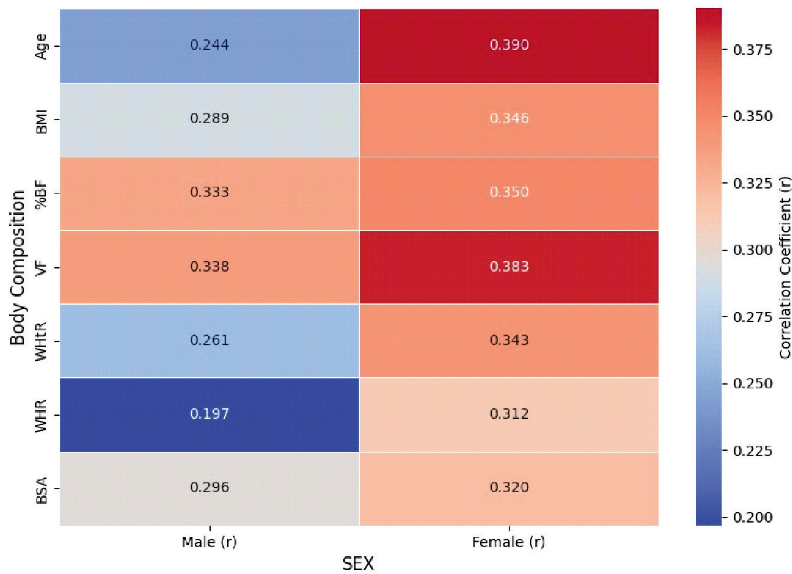

Figure 1: Heatmap of correlation between Body composition and MAP

Table 5 and Figure 2 demonstrate the regression analysis that examined the relationship between body composition predictors and Mean Arterial Pressure (MAP). For males, the final model included body fat percentage and Body Surface Area as significant predictors of MAP, explaining 15% of the variance in MAP. Specifically, %BF was positively associated with MAP (B = 0.593, β = 0.270, p < 0.001), implying that for each 1% increase in body fat, MAP increased by 0.59 mmHg, with BSA held constant. Additionally, BSA was positively associated with MAP (B = 26.63, β = 0.235, p = 0.001), depicting that individuals with a larger body surface area tended to have higher MAP. For females, the final model included Age and BMI as significant predictors, explaining 21.8% of the variance in MAP. Age was positively associated with MAP (B = 0.526, β = 0.346, p < 0.001), indicating that for each one-year increase in age, MAP increased by 0.53 mmHg after controlling for BMI. Similarly, BMI was positively associated with MAP (B = 0.98, β = 0.236, p < 0.001), suggesting that increased BMI values were associated with increased MAP. For combined sexes, the final model included Age, BSA and %BF as significant factors, explaining 19.1% of the variance in MAP. Overall, the table demonstrates sex-specific differences in the predictors of MAP.

Table 5: Regression Coefficients for Predictors of MAP

Sex		*Significant Predictors*	*B*	*β*	*Sig.*	*R*	*R^2*	*Adjusted R*
M	*MAP as Dependent variable*	**%BF**	0.593	0.270	0.000	0.388	0.150	0.140
		BSA	26.625	0.235	0.001			
F		**Age**	0.526	0.346	0.000	0.467	0.218	0.210
		BMI	0.977	0.236	0.000			
Combined		**Age**	0.329	0.076	0.000	0.437	0.191	0.184
		BSA	26.865	4.546	0.000			
		%BF	0.32	0.101	0.002			

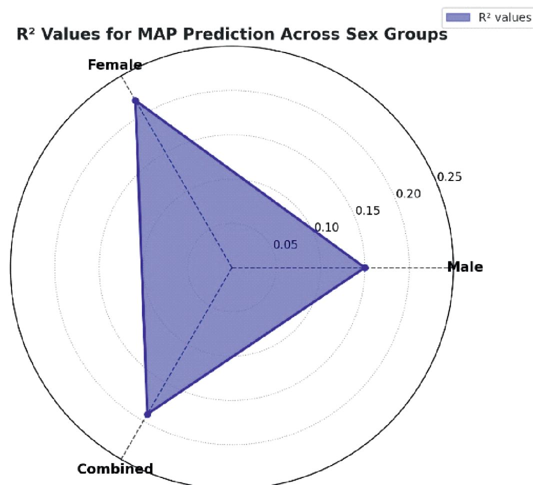

Figure 2: Regression Coefficients for Predictors of MAP

Discussion

The present study revealed that while variations in blood pressure categories exist between sexes, the difference in this population is not statistically significant. This finding contrasts with the existing literature, in which sex disparities in the prevalence of hypertension have been consistently reported. Several epidemiological studies have indicated that males tend to exhibit higher rates of hypertension than females, particularly in younger and middle-aged populations (Everett & Zajacova, 2015; Alhawari et al., 2018; Mohammad & Bansod, 2024).

This study revealed that higher body composition indices, specifically body weight, percentage body fat, and visceral fat, were correlated with increased blood pressure. Participants in the stage 2 hypertension group demonstrated the highest mean body composition measurements for both sexes. These results align with prior studies, which have consistently highlighted that increased adiposity contributes to hypertension through mechanisms such as higher vascular resistance and activation of the renin-angiotensin-aldosterone system (Landsberg et al., 2013; Hall et al., 2015; Whelton et al., 2018).

Based on metrics from the National Family Health Surveys (NFHS) 4 and 5, the prevalence of hypertension in India was 20.4% and 22.8%, respectively. When classified according to Mean Arterial Pressure ranges, the findings indicated that 69.9% of males and 61.8% of females in this study fell under the hypertension category. Furthermore, a higher prevalence of overweight and obesity was detected in females. A similar trend in the prevalence of obesity among females was reported by Vuvor (2017). A comparison of the NFHS surveys suggests that the extent of hypertension is significantly elevated within this specific community. Moreover, a strong association between hypertension and excess body weight was identified, with overweight and obese adults exhibiting a higher prevalence of hypertension than those with normal weight. Additionally, the prevalence of hypertension showed a consistent increase with rising BMI across both sexes, a pattern previously documented by Kaufman et al. (1997). Mungreiphy et al. (2011) further reported that blood pressure increases steadily with age, with the highest levels observed in the oldest age group, which aligns with the observations of the present investigation. According to the NFHS 5 data, the prevalence of overweight individuals was 23% among females and 22.1% among males, while obesity was reported in 40% of females and 12% of males. In contrast, this study presents a slightly different scenario, with an average of 20% of participants classified as overweight, which is marginally lower than the NFHS 5 figures. Furthermore, the prevalence of obesity in this study was significantly lower, with only 2.5% of females and 0.6% of males being categorised as obese. Based on the WHR classification, 12.1% of males and 45.1% of females were identified as high-risk. These body composition indicators collectively suggest that a substantial proportion of the population

is at an elevated metabolic risk. Notably, the BMI classification provided a somewhat different perspective, with the majority of participants falling within the normal weight range (67.6% of males and 58.3% of females), and only a small fraction was classified as obese. This discrepancy highlights the potential limitations of BMI as the sole measure of hypertension risk and underscores the necessity of incorporating additional indicators, such as WHR and WHtR, to assess metabolic and cardiovascular risks more accurately (Ross et al., 2020). Interestingly, while a considerable proportion of males fell into the low-risk WHR category, a contrasting trend was observed among females, with 45.1% classified as high risk. Similarly, the WHtR classification revealed significant sex-based differences, indicating a broader distribution of females in the high-risk categories.

From the Spearman correlation coefficients, it is evident that blood pressure was significantly positively correlated with the selected BC variables in both sexes. In males, visceral fat ($r = 0.338$, $p < 0.01$) and % body fat ($r = 0.333$, $p < 0.01$) exhibited the strongest positive correlations with MAP. This finding suggests that central adiposity, particularly visceral fat accumulation, may be a primary determinant of blood pressure in males, which is consistent with earlier research implying that visceral fat plays a more significant role in cardiovascular risk than obesity (Neeland et al., 2019). For females, age emerged as the strongest correlate of MAP ($r = 0.390$, $p < 0.01$), closely trailed by visceral fat ($r = 0.383$, $p < 0.01$) and body fat percentage ($r = 0.350$, $p < 0.01$). These results highlight the combined effects of ageing and adiposity on blood pressure in females. The stronger correlation coefficients observed in females compared to those in males suggest that body composition exerts a more pronounced effect on MAP in this group. This sex-specific disparity may be ascribed to variations in fat distribution and hormonal influences on blood pressure regulation, as oestrogen has been shown to modulate vascular function and adiposity differently between the sexes (Reckelhoff, 2018). Therefore, among several body composition variables, BMI, %BF and VF were found to provide better values, and these variables can be considered important predictors of blood pressure. In contrast, many other investigations carried out globally have similar opinions. Lu et al. (2018) concluded that BMI is the most sensitive indicator for predicting elevated blood pressure, followed by WC and WHtR.

In their study, they found that WHR was the lowest predictor. In this study, WHR was also found to be the lowest indicator of blood pressure. Another study by Gajalakshmi et al. (2018) predicted that BMI had the strongest effect on blood pressure. One of the studies conducted by Vuvor (2011) concluded that an increase in BMI is undoubtedly positively influenced by BP among adults. Although BMI may be an important indicator, having a normal BMI does not nullify the risk of hypertension (Jain et al., 2023). Jain et al. (2023) showed that among Asian Indians, parental history is another indicator that can alter the risk of hypertension in individuals with low or moderate BMI. A study by Dahel-Mekhancha et al. (2022) reported that BMI, WHR, WHtR, and BIA indicators also predicted blood pressure, but they suggested that crude anthropometric measurements could be better predictors than these indices. The present study does not support this hypothesis. In the current study, body composition indices showed better correlation values than crude anthropometric measurements. One study conducted by Nimkarn et al. (2022) proposed that, despite BMI, WHtR outperforms the BMI z-score in predicting the risk of hypertension. In our study, female WHtR can be considered a good predictor of blood pressure, but in the case of males, it seems to be on the list of low indication capacity.

Regression analysis further reinforced these findings, revealing that body fat percentage and body surface area (BSA) were significant predictors of MAP in males, explaining 15% of the variance. For females, age and BMI were significant predictors, explaining 21.8% of the variance. The inclusion of age as a predictor for females indicates that the risk of hypertension in this group is influenced by the interplay between physiological ageing and body composition, consistent with the findings of Scuteri et al. (2011). Recent studies have confirmed these findings. Klisic et al. (2024) emphasised that age, body fat percentage, and metabolic indicators contribute significantly to the risk of hypertension in postmenopausal women, with the interplay between ageing and body composition playing a crucial role in cardiovascular health. Similarly, Pedicino & Volpe (2025) found that body surface area and BMI remained strong predictors of hypertension, particularly in individuals under 65 years of age, highlighting the importance of obesity-related metrics in blood pressure regulation. These studies suggest that while age influences MAP more prominently in females, body composition

factors such as BMI and BSA are critical across all age groups. Additionally, Ogut (2024) explored metabolic and dermatological correlations and demonstrated that increased BMI and %BF are associated with systemic metabolic disturbances, including elevated MAP and hypertension risk. This finding supports the notion that adiposity-related physiological changes have systemic effects that influence arterial stiffness and vascular resistance.

In the combined model, age, BSA, and %BF emerged as significant predictors, explaining 19.1% of the variance in the MAP. This suggests that, irrespective of sex, overall body composition and ageing are fundamental determinants of arterial pressure. This reinforces the necessity for sex-specific approaches to managing hypertension risk, considering the distinct contributions of body composition and ageing.

Several studies from all over the globe have suggested that different body composition indices are useful tools for predicting the risk of hypertension. The best indicator of hypertension, as suggested by different researchers, probably differs due to variations across the population, region, body constitution, diet patterns, lifestyle, genetics, and so on. In this context, Age, BMI, %BF and BSA were identified as the most important predictors of blood pressure for their user-friendly metrics.

Conclusion

This study and past literature clearly show that body composition is a significant key factor in sustaining health attributes. The overall maintenance of body composition and tracking of its parameters should be considered to ensure a normal metabolism. Indeed, fat levels have always been acting as an underlying cause of many biological factors. Similarly, increases in body fat, weight, and surface area affect biological metabolism. This investigation aimed to conclude the overall attributes of body composition on blood pressure. Previously, age and family history were highlighted as factors for the increase in blood pressure; however, in the recent decade, abnormal lifestyles including westernisation (cheap, high sugar content, adulterated food), sedentary lifestyle, more screen time, abnormal sleep cycle, psychological distress, etc., have forced one's blood parameters to an extensive level. This problem does not knock in a single day but

accumulates over a long period. This study showed an increase in mean body composition with an increase in blood pressure. This research also showed an association between these variables and blood pressure. Lastly, it can be concluded that proper care of the body can prevent unwanted non-communicable diseases. Therefore, a better and healthier lifestyle is a better fit for the modern world. It is completely dependent on us whether we want to maintain our body composition or invest in the aftereffects and medicine.

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References

Alhawari, H. H., Al-Shelleh, S., Al-Saudi, A., Aljbour Al-Majali, D., Al-Faris, L., & AlRyalat, S. A. (2018). Blood pressure and its association with gender, body mass index, smoking, and family history among university students. *International Journal of Hypertension, 2018*, Article 4186496. https://doi.org/10.1155/2018/4186496

Al-Sendi, A., Shetty, P., Musaiger, A., & Myatt, M. (2003). Relationship between body composition and blood pressure in Bahraini adolescents. *British Journal of Nutrition, 90*(4), 837–844. https://doi.org/10.1079/BJN2003963

Dahel-Mekhancha, C. C., Rolland-Cachera, M. F., Botton, J., Karoune, R., Sersar, I., Yagoubi-Benatallah, L., Bouldjedj, I., Benini, A., Fezeu, L. K., Nezzal, L., & Mekhancha, D. E. (2023). Body composition and anthropometric indicators as predictors of blood pressure: A cross-sectional study conducted in young Algerian adults. *British Journal of Nutrition, 129*(11), 1993–2000. https://doi.org/10.1017/S0007114522002719

Dean, L. (2005). *Blood groups and red cell antigens*. National Center for Biotechnology Information (US).

Everett, B., & Zajacova, A. (2015). Gender differences in hypertension and hypertension awareness among young adults. *Biodemography and Social Biology, 61*(1), 1–17. https://doi.org/10.1080/19485565.2014.929488

Farhud, D. D., & Zarif Yeganeh, M. (2013). A brief history of human blood groups. *Iranian Journal of Public Health, 42*(1), 1–6.

Gajalakshmi, V., Lacey, B., Kanimozhi, V., Sherliker, P., Peto, R., & Lewington, S. (2018). Body-mass index, blood pressure, and cause-specific mortality in India:

A prospective cohort study of 500,810 adults. *The Lancet Global Health, 6*(7), e787–e794. https://doi.org/10.1016/S2214-109X(18)30267-5

Gupta, R., & Ram, C. V. S. (2019). Hypertension epidemiology in India: Emerging aspects. *Current Opinion in Cardiology, 34*(4), 331–341. https://doi.org/10.1097/HCO.0000000000000632

Hall, J. E., do Carmo, J. M., da Silva, A. A., Wang, Z., & Hall, M. E. (2015). Obesity-induced hypertension: Interaction of neurohumoral and renal mechanisms. *Circulation Research, 116*(6), 991–1006. https://doi.org/10.1161/CIRCRESAHA.115.305697

Hu, L., Hu, G., Huang, X., Zhou, W., You, C., Li, J., Li, P., Wu, Y., Wu, Q., Wang, Z., Gao, R., Bao, H., & Cheng, X. (2020). Different adiposity indices and their associations with hypertension among the Chinese population from Jiangxi province. *BMC Cardiovascular Disorders, 20*(1), 115. https://doi.org/10.1186/s12872-020-01388-2

International Institute for Population Sciences (IIPS), & ICF. (2017). *National Family Health Survey (NFHS-4), 2015–16: India*. IIPS.

International Institute for Population Sciences (IIPS), & ICF. (2021). *National Family Health Survey (NFHS-5), 2019–21: India*. IIPS.

Jain, B., Gumashta, R., Gumashta, J., Garg, R., & Vij, V. (2023). The association between body mass index and parental history of hypertension among young Indian adults. *Cureus, 15*(6), e40670. https://doi.org/10.7759/cureus.40670

Kaufman, J. S., Asuzu, M. C., Mufunda, J., Forrester, T., Wilks, R., Luke, A., Long, A. E., & Cooper, R. S. (1997). Relationship between blood pressure and body mass index in lean populations. *Hypertension, 30*(6), 1511–1516. https://doi.org/10.1161/01.HYP.30.6.1511

Klisic, A., Ahmad, R., Daka, B., & Sindhu, S. (2024). Editorial: Cardiometabolic diseases in postmenopausal women. *Frontiers in Endocrinology, 15*, 1514913. https://doi.org/10.3389/fendo.2024.1514913

Landsberg, L., Aronne, L. J., Beilin, L. J., Burke, V., Igel, L. I., Lloyd-Jones, D., & Sowers, J. (2013). Obesity-related hypertension: Pathogenesis, cardiovascular risk, and treatment. *Journal of Clinical Hypertension, 15*(1), 14–33. https://doi.org/10.1111/jch.12049

Li, W., He, Y., Xia, L., Yang, X., Liu, F., Ma, J., Hu, Z., Li, Y., Li, D., Jiang, J., Shan, G., & Li, C. (2018). Association of age-related trends in blood pressure and body composition indices in healthy adults. *Frontiers in Physiology, 9*, 1574. https://doi.org/10.3389/fphys.2018.01574

Lohman, T. G., Roche, A. F., & Martorell, R. (1988). *Anthropometric standardization reference manual*. Human Kinetics.

Lu, Y., Luo, B., Xie, J., Zhang, X., & Zhu, H. (2018). Prevalence of hypertension and prehypertension and its association with anthropometrics among children: A cross-sectional survey in Tianjin, China. *Journal of Human Hypertension, 32*(11), 789–798. https://doi.org/10.1038/s41371-018-0088-4

Mohammad, R., & Bansod, D. W. (2024). Hypertension in India: A gender-based study of prevalence and associated risk factors. *BMC Public Health, 24*, 2681. https://doi.org/10.1186/s12889-024-20097-5

Mungreiphy, N. K., Kapoor, S., & Sinha, R. (2011). Association between BMI, blood pressure, and age among Tangkhul Naga tribal males of Northeast India. *Journal of Anthropology, 2011*, Article 748147. https://doi.org/10.1155/2011/748147

Neeland, I. J., Poirier, P., & Després, J. P. (2019). Cardiovascular and metabolic heterogeneity of obesity: Clinical challenges and implications for management. *Circulation, 139*(11), 1391–1406. https://doi.org/10.1161/CIRCULATIONAHA.118.035278

Nimkarn, N., Sewarit, A., Pirojsakul, K., Paksi, W., Chantarogh, S., Saisawat, P., & Tangnararatchakit, K. (2023). Waist-to-height ratio is associated with sustained hypertension in children and adolescents with high office blood pressure. *Frontiers in Cardiovascular Medicine, 9*, 1026606. https://doi.org/10.3389/fcvm.2022.1026606

Patel, S. A., Ali, M. K., Alam, D., Yan, L. L., Levitt, N. S., Bernabe-Ortiz, A., Checkley, W., Wu, Y., Irazola, V., Gutierrez, L., Rubinstein, A., Shivashankar, R., Li, X., Miranda, J. J., Chowdhury, M. A., Siddiquee, A. T., Gaziano, T. A., Kadir, M. M., & Prabhakaran, D. (2016). Obesity and its relation with diabetes and hypertension: A cross-sectional study across four geographical regions. *Global Heart, 11*(1), 71–79.e4. https://doi.org/10.1016/j.gheart.2016.01.003

Reckelhoff, J. F. (2018). Gender differences in hypertension. *Current Opinion in Nephrology and Hypertension, 27*(3), 176–181. https://doi.org/10.1097/MNH.0000000000000402

Ross, R., Neeland, I. J., Yamashita, S., Shai, I., Seidell, J., Magni, P., & Després, J. P. (2020). Waist circumference as a vital sign in clinical practice. *Nature Reviews Endocrinology, 16*(3), 177–189. https://doi.org/10.1038/s41574-019-0310-7

Scuteri, A., Morrell, C. H., & Lakatta, E. G. (2011). The role of arterial stiffness in hypertension and cardiovascular risk in ageing. *Hypertension, 57*(5), 755–759. https://doi.org/10.1161/HYPERTENSIONAHA.110.168279

Sun, D., Zhou, T., Li, X., Heianza, Y., Liang, Z., Bray, G. A., Sacks, F. M., & Qi, L. (2019). Genetic susceptibility, dietary protein intake, and changes in blood pressure: The POUNDS Lost trial. *Hypertension, 74*(6), 1460–1467. https://doi.org/10.1161/HYPERTENSIONAHA.119.13510

Vuvor, F. (2017). Correlation of body mass index and blood pressure among adults aged 30–50 years in Ghana. *Journal of Health Research and Reviews, 4*, 115–121. https://doi.org/10.4103/jhrr.jhrr_93_16

Wang, Y., Wang, Q. J., & Wang, W. (2019). The relationship between obesity and blood pressure: A systematic review and meta-analysis. *Journal of Hypertension, 37*(6), 1195–1203. https://doi.org/10.1097/HJH.0000000000002020

Whelton, P. K., Carey, R. M., Aronow, W. S., et al. (2018). 2017 ACC/AHA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults. *Hypertension, 71*(6), 1269–1324. https://doi.org/10.1161/HYP.0000000000000066

Yüksel, S., Çoksevim, M., Meriç, M., & Şahin, M. (2021). The association of body composition parameters and simultaneously measured inter-arm systolic blood pressure differences. *Medicina, 57*(4), 384. https://doi.org/10.3390/medicina57040384