ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 02 | February - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

IMPACT OF SYSTOLIC BLOOD PRESSURE ON CARDIOVASCULAR RISK BASED ON AGE, SMOKING STATUS, BMI, AND REGION

Cardiology

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ABSTRACT

Objective: To evaluate the impact of SBP on CV risk across different age groups, gender, smoking status, body mass index (BMI) categories, and regions in India to identify high-risk subpopulations. **Methods:** This cross-sectional, observational study included adults aged 45-74 years attending community-based health camps across multiple regions of India. Data on age, gender, smoking status, BMI, SBP, and region were collected, and the mean 10-year risk was estimated using a validated population-specific risk prediction model. **Results:** A total of 2,161 participants were included. Higher SBP categories increasingly predominated with advancing age, accompanied by a progressive rise in cardiovascular risk, from mean (SD) values of 2.74 (1.25)–9.50 (4.51) in the 45–49-year group to 12.64 (1.57)–27.50 (5.17) in those aged 70–74 years. Overall, cardiovascular risk increased 1.7-fold as SBP rose from 120–139 mmHg to 140–159 mmHg across age groups. Men comprised the majority in the 120–139 mmHg category and exhibited higher absolute risk than women at comparable SBP levels. Smokers and individuals with higher BMI demonstrated steeper increases in cardiovascular risk with rising SBP. Regionally, higher SBP clustered predominantly in southern India, where the greatest risk escalation was observed. **Conclusion:** These findings highlight the strong, dose-dependent association between SBP and cardiovascular risk across key demographic and clinical subgroups, underscoring the need for targeted SBP-lowering interventions in high-risk populations.

KEYWORDS

Systolic Blood Pressure, Cardiovascular Risk, BMI, Smoking, Age, Geographic Variation, India

1. INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality globally, imposing a substantial burden on the healthcare system and societies. Around 19.8 million people died due to CVD, accounting for 32% of all deaths worldwide. Of these, 85% were from stroke and heart attack [1]. India has experienced rapid epidemiological transitions over the last decade. Approximately 63% of deaths in India are from non-communicable diseases, and of these, 27% were attributed to CVD, which also counts for deaths from the 40-69 years age group [2].

Studies have identified hypertension, obesity, and physical inactivity as potential risk factors for CVD [3]. Elevated systolic blood pressure (SBP) is one of the most significant and modifiable risk factors for the development of CVD [4-6]. Numerous population-based studies demonstrated the magnitude of the associations between higher SBP and CV risk; however, the strengths of these associations may differ based on individual characteristics, including age, smoking behaviour, body mass index (BMI) and regions [7-9].

Age is a particularly significant modifier of blood pressure (BP) related risk. As individuals grow older, arterial stiffness and vascular remodelling amplify the adverse effects of elevated SBP, potentially altering both absolute and relative CV risk. Understanding the age-related trend of elevated SBP is important for preventing CV risk [10-12]. Similarly, smoking is a major global health concern that significantly exacerbates vascular dysfunctions, inflammatory processes and oxidative stress. These mechanisms may interact with elevated SBP in complex ways, further increasing the likelihood of CV events among smokers [13,14].

In addition, BMI key indicator of overall adiposity, has been shown impact on hemodynamic load, metabolic risk and endothelial function. Obesity may exacerbate the harmful effects of elevated SBP, whereas low BMI has been associated with its own distinct CV vulnerabilities [13, 15]. Beyond these factors, geographical variations may also influence the CV risk. As populations across the south region consistently show a higher prevalence of CV risk, while the other regions often exhibit lower rates [16]. These disparities are linked to variations in lifestyle, environmental exposures, socioeconomic factors and baseline health profiles [17].

Although each risk factor is well-established, the extent to which SBP interacts with age, smoking status, BMI and region to influence CV risk remains less clear. A better understanding of these interactions is essential to improve risk stratification and guide targeted preventive strategies. The present study aimed to evaluate the impact of SBP on CV risk across different age groups, smoking status, BMI, and regions, to identify subpopulations that may benefit from BP-lowering interventions.

2. MATERIALS AND METHODS

2.1. Study Design and Population

This cross-sectional study evaluated the association between SBP and CV risk across demographic and clinical subgroups. Data were collected from adults attending community-based health camps conducted across multiple regions of India. Participants aged 45-74 years were included, as this age group represents a population at elevated risk for CV events.

2.2: Data Collection and CV Assessment

Data collected included age, gender, smoking status, region of residence, and SBP. Anthropometric measurements were obtained using calibrated equipment and BMI was calculated as weight (kg) divided by height squared (m^2).

Ten-year CV risk was estimated using the World Health Organization (WHO) CVD Risk Prediction Model, which is validated for use in diverse populations, including South Asian regions. Individual risk scores were computed using a STATA do-file developed based on the WHO risk equations, incorporating age, sex, smoking status, SBP, BMI, and regional risk calibration (Supplementary Material S1).

Participants were categorized into predefined SBP ranges (<120, 120-139, 140-159, 160-179, and ≥180 mmHg) to assess the dose-dependent relationship between SBP and predicted CV risk.

2.3: Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of [institution name], and written informed consent was obtained from all participants prior to inclusion. The study was conducted in accordance with the Declaration of Helsinki and applicable national guidelines for research involving human participants.

2.4: Statistical Analysis

Data were analyzed using SPSS Statistics V22.0. Descriptive statistics were used to describe categorical variables (frequency and percentages) and continuous variables (mean and standard deviation [SD] or median and range [depending on the normality of data]). Analysis were stratified by age, gender, BMI, smoking status, and region. Mean CV risk across SBP categories was compared, and fold increases in predicted CV risk were calculated using the lowest SBP category (<120 mmHg or 120–139 mmHg, as appropriate) as the reference group.

3. RESULTS

A total of 2,161 participants were included in the study. Most participants had SBP in the 120-139 mmHg range (N=1002), followed by 140-159 mmHg (N=723), <120 mmHg (N=196), 160-179 mmHg (N=214), and ≥180 mmHg (N=26).

In the 45-49-year age group, 69.90% of participants were in the <120 mmHg category, with mean (SD) CV risk scores ranging from 2.74 (1.25) to 9.50 (4.51) in the ≥180 mmHg category. Among those aged 50-54 years, 21.44% were in the 140-159 mmHg category, with mean (SD) CV risk scores ranging from 4.11 (1.42) to 14.33 (5.13) in the ≥180 mmHg category. In the 55-59-year group, 22.90% had SBP in the 160-179 mmHg range, with mean (SD) CV risk scores ranging from 5.10 (1.10) to 27.00 (3.46).

In older age groups (60-74 years), the largest proportions shifted towards the ≥180 mmHg category: 23.08% in the 60-64-year group, with mean (SD) CV risk scores ranging from 7.00 (1.73) to 19.00 (7.04); 15.38% in the 65-69-year group, with scores ranging from 9.50 (1.38) to 23.50 (8.54); and 23.08% in the 70-74-year group, with scores ranging from 12.64 (1.57) to 27.50 (5.17) (Table 1). Overall, a 1.7-fold increase in CV risk was observed as SBP increased from 120-139 mmHg to 140-159 mmHg across age groups.

Among genders, the majority of men (78.77%) were in the 120-139 mmHg SBP category (Suppl. Table 1). In men, the mean (SD) CV risk score increased from 4.41 (3.01) at SBP <120 mmHg to 23.88 (8.40) at SBP ≥180 mmHg. In women, CV risk scores increased from 2.58 (1.84) at SBP <120 mmHg to 15.50 (6.44) at SBP ≥180 mmHg (Figure 1). Across the transition from 120-139 mmHg to 140-159 mmHg, CV risk increased by 1.73-fold in men and 1.64-fold in women.

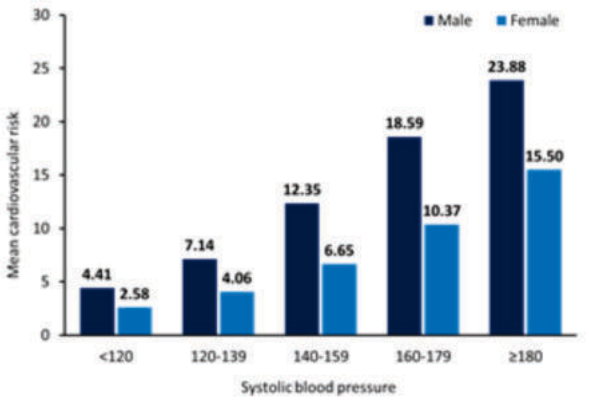

Figure 1: Mean Predicted Cardiovascular Risk Across Increasing Systolic Blood Pressure Categories, Stratified by Sex

The proportion of smokers was highest in the 140-159 mmHg SBP category (42.96%), followed by 42.86% in the 160-179 mmHg category and 38.46% in the≥180 mmHg category (Suppl. Table 2). Mean (SD) CV risk increased from 5.75 (2.45) at SBP <120 mmHg to 26.20 (7.39) at SBP ≥180 mmHg (Figure 2). Overall, a 4.56-fold increase in CV risk was observed as SBP increased from 120-139 mmHg to 140-159 mmHg.

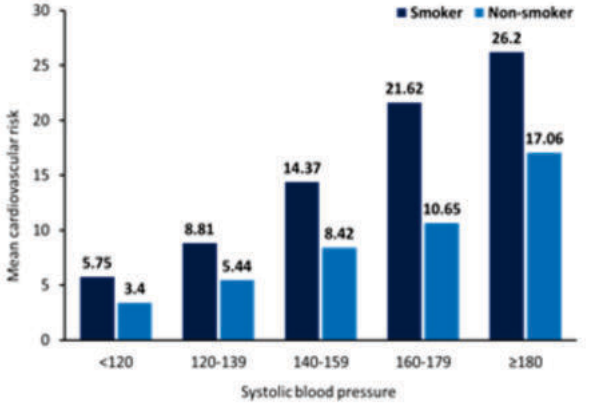

Figure 2: Mean Predicted Cardiovascular Risk Across Increasing Systolic Blood Pressure Categories, Stratified by Smoking Status

Among participants with BMI <20 kg/m^2, 23.47% had SBP <120 mmHg, with mean (SD) CV risk scores ranging from 2.93 (1.81) to 11.78 (5.47) in the 160-179 mmHg category. In the 20-24 kg/m^2 group, 47.80% were in the 120-139 mmHg category, with CV risk scores ranging from 4.02 (3.16) to 16.33 (8.50) in ≥180 mmHg category. In the 25-29 kg/m^2 group, 41.91% had SBP in the 140-159 mmHg range, with CV risk scores ranging from 4.13 (2.51) to 19.57 (8.46).

In higher BMI categories, elevated SBP predominated. In participants with BMI 30-35 kg/m^2, 25.23% were in the 160-179 mmHg category and 38.46% were in the ≥180 mmHg category, with CV risk scores ranging from 6.71 (5.38) to 20.20 (6.80). Among those with BMI ≥35 kg/m^2, 18.69% and 19.23% fell into these categories, respectively, with CV risk increasing from 4.54 (2.33) to 28.20 (7.92). Overall, the mean CV risk increased with higher SBP and BMI (Table 2). The mean fold increase in CV risk across all BMI groups was 1.54-fold as SBP increased from 120-139 mmHg to 140-159 mmHg.

Across geographic zones, the South accounted for the largest proportion of participants in higher SBP categories, comprising 44.54% in 140-159 mmHg, 67.76% in 160-179 mmHg, and 57.69% in the ≥180 mmHg categories. Mean (SD) CV risk scores increased with rising SBP across all zones. CV risk ranged from 3.03 (1.54) to 21.13 (8.64) in the South, 4.12 (2.97) to 20.75 (11.59) in the East, and 6.26 (4.35) to 19.29 (7.54) in the North. In the West, mean CV risk increased from 3.42 (1.97) to 14.58 (5.62) up to the 160-179 mmHg category (Table 3). Regionally, CV risk increased by 1.87-fold in the South, 1.75-fold in the West, 1.61-fold in the East, and 1.55-fold in the North.

4. DISCUSSION

In the present cross-sectional study, CV risk increased progressively across higher SBP categories, with clinically relevant variation observed across age, gender, smoking status, BMI, and geographic region. The pattern of higher CV risk at elevated SBP levels was more evident with advanced age and appeared to be more pronounced among men, smokers, individuals with higher BMI, and participants from certain regions. These findings suggest that the relationship between SBP and CV risk is influenced by multiple demographics, lifestyle, and regional factors, and that elevated SBP commonly coexists with other risk-enhancing characteristics.

The age-stratified pattern observed in this study, wherein CV risk rose progressively with increasing SBP and advancing age, is consistent with findings reported in large population-based cohorts. Both the Singapore Chinese Health Study and the China Kadoorie Biobank have shown that SBP levels of 120-139 mmHg are generally associated with lower CV mortality, with higher risk observed at SBP ≥140 mmHg among middle-aged and older adults. This aligns with our descriptive observation of higher mean CV risk scores in elevated SBP categories [18,19]. Previous literature has also suggested that the relative contribution of elevated SBP may be greater in younger adults and attenuate with age, although elevated SBP remains clinically relevant across all age groups [20.21]. Furthermore, the 2019 ACC/AHA Guideline notes that while the relative risk of CV events associated with elevated SBP and diastolic blood pressure may decline with age, the absolute burden of CV risk increases in older individuals (≥65 years), emphasising the importance of BP monitoring and management throughout the lifespan [22].

In the present study, CV risk showed a consistent rise pattern with increasing SBP in both men and women, indicating a broadly similar trend across gender. Men were more frequently represented in the 120-139 mmHg SBP category and exhibited higher absolute CV risk scores at elevated SBP levels, while women also demonstrated increasing CV risk with rising SBP. These observations are in line with descriptive findings of NHANES and other large cohorts studies [17, 23, 24]. Prior studies have suggested that women may experience a relatively steeper increase in CV risk at lower SBP thresholds, particularly after menopause, potentially related to hormonal changes, vascular remodelling, and loss of estrogen-mediated cardioprotection [23]. Evidence from Asian populations similarly indicates that elevated SBP is associated with a substantial increase in CV risk in both genders [24]. Taken together, these findings underscore the relevance of gender-specific considerations in CV risk evaluation and BP management.

Regarding smoking status, smokers were more commonly observed in higher SBP categories, and mean CV risk scores increased markedly with rising SBP among smokers. The gradient of CV risk across SBP categories among smokers suggests a combined influence of smoking and elevated SBP on overall CV risk. This trend is consistent with large pooled cohort analyses demonstrating a log-linear relationship between SBP and CV outcomes in smokers, wherein smoking appears to exacerbate the adverse CV risk profile associated with elevated SBP [25,26]. Previous studies have also reported higher CV mortality among smokers with hypertension compared with non-smokers [25], supporting the descriptive pattern observed in the present study. Collectively, these findings highlight the importance of addressing both BP control and smoking behaviour in CV risk reduction strategies.

Across all BMI categories, CV risk increased with higher SBP, with higher BMI groups showing a greater concentration of participants in elevated SBP categories. Overweight and obese participants were more frequently observed in higher SBP categories and demonstrated higher CV risk scores, suggesting an additive clustering of cardiometabolic risk factors. These finding are in line with reports from large Asia-pacific cohort studies reporting substantially higher CVD risk among obese individuals with elevated SBP compared with those of normal weight [27]. Evidence from hypertensive cohorts has also described a U-shaped relationship between BMI and CVD mortality, with increased risk at both low and high BMI extremes [28]. Additionally, metabolic abnormalities such as dyslipidemia, which commonly coexist with higher BMI and elevated BP, may further contribute to CV risk through mechanisms involving atherosclerosis and endothelial dysfunction.

Geographic variation in CV risk patterns was also observed, with CV risk increasing alongside SBP across all zones, and the south zone accounting for a larger proportion of participants in elevated SBP categories. Prior population-based analyses have demonstrated substantial geographic heterogeneity in CV risk across India, with South Indian states such as Kerala reporting higher predicted 10-year CV risk and hypertension prevalence, while some eastern states report comparatively lower risk [29,30]. These regional variations in BP-related CV risk likely reflect underlying variation in dietary patterns, physical activity, socioeconomic status, healthcare access, and broader social determinants of health.

A key strength of this study is that, to our knowledge, it is among the first to describe regional patterns of CV risk in relation to SBP across India while simultaneously considering multiple demographic and lifestyle factors. The large and diverse population-based comparisons enhance the generalizability of the findings. However, several limitations warrant consideration. The cross-sectional design precludes casual interference, the analysis lack certain clinical variables, and formal statistical testing was not performed, which limits inference regarding the strength of associations. Future longitudinal studies incorporating comprehensive clinical parameters and inferential analyses are needed to further elucidate the observed patterns and their implications for CV risk prediction and prevention.

5. CONCLUSION

The findings of this study indicate that higher SBP is consistently accompanied by higher CV risk, and this pattern is more evident among older individuals, men, smokers, those with higher BMI, and participants from certain geographic regions. These observations underscore the relevance of integrated prevention strategies focusing on BP control, weight management, smoking cessation, and region-specific interventions to reduce CV risk in the Indian population.

Table 1: Association of Systolic Blood Pressure with Age Groups

	Systolic Blood Pressure (mmHg)				
Age group (years)	<120 (N=196)	120-139 (N=1002)	140-159 (N=723)	160-179 (N=214)	≥180 (N=26)
45-49, n (%)	137 (69.90)	512 (51.10)	198 (27.39)	40 (18.69)	4 (15.38)
CVD risk score, mean (SD)	2.74 (1.25)	4.43 (1.96)	6.75 (3.31)	9.23 (4.61)	9.50 (4.51)
Median (range)	2.00 (2.00- 7.00)	3.50 (2.00-10.00)	5.00 (3.00-13.00)	6.50 (5.00-17.00)	8.00 (6.00-16.00)
50-54, n (%)	27 (13.78)	191 (19.06)	155 (21.44)	41 (19.16)	3 (11.54)
CVD risk score, mean (SD)	4.11 (1.42)	5.76 (2.13)	8.55 (3.30)	10.85 (4.53)	14.33 (5.13)
Median (range)	4.00 (3.00-8.00)	5.00 (3.00-12.00)	7.00 (5.00-15.00)	9.00 (6.00-20.00)	13.00 (10.00-20.00)
55-59, n (%)	10 (5.10)	106 (10.58)	128 (17.70)	49 (22.90)	3 (11.54)
CVD risk score, mean (SD)	5.10 (1.10)	7.74 (2.22)	11.20 (3.45)	17.18 (8.02)	27.00 (3.46)
Median (range)	5.00 (4.00-8.00)	7.00 (5.00-12.00)	11.50 (6.00-18.00)	16.00 (8.00-28.00)	29.00 (23.00-29.00)
60-64, n (%)	5 (2.55)	86 (8.58)	125 (17.29)	41 (19.16)	6 (23.08)
CVD risk score, mean (SD)	7.00 (1.73)	9.52 (2.21)	13.19 (3.59)	16.10 (5.83)	19.00 (7.04)
Median (range)	6.00 (6.00-10.00)	9.00 (7.00-15.00)	13.00 (8.00-21.00)	12.00 (11.00-26.00)	17.50 (13.00-32.00)
65-69, n (%)	6 (3.06)	66 (6.59)	56 (7.75)	19 (8.88)	4 (15.38)
CVD risk score, mean (SD)	9.50 (1.38)	12.62 (2.29)	16.41 (3.37)	19.74 (6.31)	23.50 (8.54)
Median (range)	9.00 (8.00-12.00)	12.00 (9.00-17.00)	15.00 (11.00-22.00)	18.00 (13.00-30.00)	20.00 (18.00-36.00)
70-74, n (%)	11 (5.61)	41 (4.09)	61 (8.44)	24 (11.21)	6 (23.08)
CVD risk score, mean (SD)	12.64 (1.57)	15.78 (1.71)	20.51 (3.52)	24.17 (6.17)	27.50 (5.17)
Median (range)	12.00 (11.00-16.00)	16.00 (13.00-21.00)	19.00 (15.00-28.00)	22.00 (17.00-34.00)	27.00 (23.00-37.00)
CVD, cardiovascular; SD, standard deviation.					

Table 2: Association of Systolic Blood Pressure with BMI

	Systolic Blood Pressure (mmHg)				
BMI (kg/m²)	<120 (N=196)	120-139 (N=1002)	140-159 (N=723)	160-179 (N=214)	≥180 (N=26)
<20, n (%)	46 (23.47)	63 (6.29)	21 (2.90)	9 (4.21)	1 (3.85)
CVD risk score, mean (SD)	2.93 (1.81)	5.25 (2.85)	7.62 (4.88)	11.78 (5.47)	-
Median (range)	2.00 (2.00-11.00)	5.00 (2.00-14.00)	6.00 (3.00-22.00)	13.00 (5.00-20.00)	-
20-24, n (%)	82 (41.84)	479 (47.80)	195 (26.97)	51 (23.83)	3 (11.54)
CVD risk score, mean (SD)	4.02 (3.16)	5.71 (3.39)	9.38 (4.80)	11.78 (6.28)	16.33 (8.50)
Median (range)	2.00 (2.00-16.00)	4.00 (3.00-19.00)	8.00 (4.00-23.00)	10.00 (5.00-28.00)	13.00 (10.00-26.00)
25-29, n (%)	48 (24.49)	331 (33.03)	303 (41.91)	60 (28.04)	7 (26.92)
CVD risk score, mean (SD)	4.13 (2.51)	7.30 (3.84)	11.42 (5.31)	15.58 (7.85)	19.57 (8.46)
Median (range)	3.00 (2.00-13.00)	7.00 (3.00-21.00)	11.00 (4.00-25.00)	13.50 (5.00-30.00)	22.00 (7.00-28.00)
30-35, n (%)	7 (3.57)	81 (8.08)	130 (17.98)	54 (25.23)	10 (38.46)
CVD risk score, mean (SD)	6.71 (5.38)	7.52 (3.72)	12.14 (5.45)	15.78 (7.00)	20.20 (6.80)
Median (range)	4.00 (2.00-14.00)	8.00 (3.00-17.00)	11.00 (4.00-27.00)	15.00 (5.00-32.00)	19.00 (13.00-37.00)
≥35, n (%)	13 (6.63)	48 (4.79)	74 (10.24)	40 (18.69)	5 (19.23)
CVD risk score, mean (SD)	4.54 (2.33)	8.35 (3.66)	11.97 (5.55)	19.43 (8.10)	28.20 (7.92)
Median (range)	4.00 (2.00-7.00)	10.00 (3.00-18.00)	13.00 (4.00-28.00)	20.00 (6.00-34.00)	29.00 (15.00-36.00)
BMI, body mass index; CVD, cardiovascular disease; SD, standard deviation.					

Table 3: Association of Systolic Blood Pressure with Zone

	Systolic Blood Pressure (mmHg)				
Zone	<120 (N=196)	120-139 (N=1002)	140-159 (N=723)	160-179 (N=214)	≥180 (N=26)
North, n (%)	34 (17.35)	115 (11.48)	74 (10.24)	28 (13.08)	7 (26.92)
CVD risk score, mean (SD)	6.26 (4.35)	6.94 (3.59)	10.76 (5.70)	14.50 (7.04)	19.29 (7.54)
Median (range)	5.00 (2.00-16.00)	6.00 (3.00-19.00)	9.00 (4.00-25.00)	13.00 (5.00-30.00)	20.00 (6.00-28.00)
East, n (%)	42 (21.43)	422 (42.12)	273 (37.76)	29 (13.55)	4 (15.38)
CVD risk score, mean (SD)	4.12 (2.97)	7.35 (4.00)	11.81 (5.11)	13.55 (7.03)	20.75 (11.59)
Median (range)	3.00 (2.00-14.00)	6.00 (3.00-21.00)	12.00 (4.00-25.00)	11.00 (5.00-30.00)	18.00 (10.00-37.00)
South, n (%)	70 (35.71)	308 (30.74)	322 (44.54)	145 (67.76)	15 (57.69)
CVD risk score, mean (SD)	3.03 (1.54)	5.61 (3.31)	10.48 (5.50)	15.84 (8.00)	21.13 (8.64)
Median (range)	2.00 (2.00-8.00)	4.00 (2.00-19.00)	9.00 (3.00-28.00)	14.00 (5.00-34.00)	22.00 (7.00-36.00)
West, n (%)	50 (25.51)	157 (15.67)	54 (7.47)	12 (5.61)	0
CVD risk score, mean (SD)	3.42 (1.97)	5.48 (2.71)	9.61 (4.44)	14.58 (5.62)	-
Median (range)	3.00 (2.00-11.00)	4.00 (2.00-15.00)	9.00 (4.00-25.00)	14.50 (5.00-28.00)	-
CVD, cardiovascular disease; SD, standard deviation.					

Funding: This study was funded by USV Pvt Ltd., Mumbai.

Conflict of Interest: Aushili M and Amit Gupta are employees of USV Pvt Ltd., Mumbai. All other authors have no conflict of interest to declare.

REFERENCES

[1] Cardiovascular diseases (CVDs) Data available at https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds). Last accessed on Dec 8, 2025.
[2] Cardiovascular diseases. Data available at https://www.who.int/india/health-topics/cardiovascular-diseases. Last accessed on 9 dec 2025.
[3] Adhikary D, Barman S, Ranjan R, Stone H. A Systematic Review of Major Cardiovascular Risk Factors: A Growing Global Health Concern. Cureus. 2022;14(10): e30119.
[4] Fuchs FD, Whelton PK. High Blood Pressure and Cardiovascular Disease. Hypertension. 2020;75(2):285-292.
[5] Razo C, Welgan CA, Johnson CO, McLaughlin SA, Iannucci V, Rodgers A, et al. Effects of elevated systolic blood pressure on ischemic heart disease: a Burden of Proof study. Nat Med. 2022;28(10):2056-2065.
[6] Brunström M, Carlberg B. Association of Blood Pressure Lowering With Mortality and Cardiovascular Disease Across Blood Pressure Levels: A Systematic Review and Meta-analysis. JAMA Intern Med. 2018;178(1):28–36.
[7] Wan EYF, Yu EYT, Chin WY, Barrett JK, Wong ICK, Chan EWY, et al. Age-Specific Associations of Usual Blood Pressure Variability With Cardiovascular Disease and Mortality: 10-Year Diabetes Mellitus Cohort Study. J Am Heart Assoc. 2021;10(17): e019026.
[8] Lewington S, Clarke R, Qizilbash N, Peto R, Collins R; Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. Lancet. 2002;360(9349):1903-13.
[9] Fagard RH. Smoking amplifies cardiovascular risk in patients with hypertension and diabetes. Diabetes Care. 2009;32 Suppl 2(Suppl 2):S429-S431.
[10] Ahmed B, Rahman AA, Lee S, Malhotra R. The Implications of Aging on Vascular Health. International Journal of Molecular Sciences. 2024; 25(20):11188.
[11] Sun Z. Aging, arterial stiffness, and hypertension. Hypertension. 2015;65(2):252-256.
[12] Laurent S, Boutouyrie P. Arterial Stiffness and Hypertension in the Elderly. Front Cardiovasc Med. 2020;7:544302.
[13] Nishiyama M, Kimijima M, Muto T, Kimura K. Presence of an interaction between smoking and being overweight increases risks of hypertension, diabetes, and cardiovascular disease in outpatients with mood disorders. Environ Health Prev Med. 2012;17(4):285-91.
[14] Tan J, Zhang X, Wang W, Yin P, Guo X, Zhou M. Smoking, Blood Pressure, and Cardiovascular Disease Mortality in a Large Cohort of Chinese Men with 15 Years Follow-up. Int J Environ Res Public Health. 2018;15(5):1026.
[15] Tsukinoki R, Murakami Y, Huxley R, Lam TH, Fang X, Suh I, et al. P2-309 Impact of excess weight on the relationship between blood pressure and cardiovascular disease: the Asia Pacific Cohort Studies Collaboration. Journal of Epidemiology & Community Health. 2011;65(Suppl 1):A307-8.
[16] Brereton BJ, Desai RV, Yarrarapu SNS, Matos Urena JG, Jain AP. Regional Disparities of Cardiovascular Risk Factors and Major Cardiovascular Events in Non-electively Hospitalized Young Adults. J Community Hosp Intern Med Perspect. 2023;13(2):1-6.
[17] Hajjar I, Kotchen T. Regional variations of blood pressure in the United States are associated with regional variations in dietary intakes: the NHANES-III data. The Journal of nutrition. 2003;133(1):211-4.
[18] Koh AS, Talaei M, Pan A, Wang R, Yuan JM, Koh WP. Systolic blood pressure and cardiovascular mortality in middle-aged and elderly adults - The Singapore Chinese Health Study. Int J Cardiol. 2016;219:404-409.
[19] Guo J, Lv J, Guo Y, Bian Z, Zheng B, Wu M, et al. Association between blood pressure categories and cardiovascular disease mortality in China. PLoS One. 2021;16(7): e0255373.
[20] Wan EYF, Yu EYT, Chin WY, Wong ICK, Chan EWY, Chen S, et al. Age-Specific Associations Between Systolic Blood Pressure and Cardiovascular Disease: A 10-Year Diabetes Mellitus Cohort Study. J Am Heart Assoc. 2020;9(14):e015771
[21] Fujiyoshi A, Ohkubo T, Miura K, Murakami Y, Nagasawa SY, Okamura T, et al. Blood pressure categories and long-term risk of cardiovascular disease according to age group in Japanese men and women. Hypertension research. 2012;35(9):947-53.
[22] Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2019;140(11) : e563-e595.
[23] Elfassy T, German CA, Muntner P, Choi E, Contreras G, Shimbo D, et al. Blood Pressure and Cardiovascular Disease Mortality Among US Adults: A Sex-Stratified Analysis, 1999-2019. Hypertension. 2023;80(7):1452-1462.
[24] Lin YT, Chen YR, Wei YC. Evaluating sex differences in the effect of increased systolic blood pressure on the risk of cardiovascular disease in Asian populations: a systematic review and meta-analysis. Global Heart. 2022;17(1):70.
[25] Nakamura K, Barzi F, Lam TH, Huxley R, Feigin VL, Ueshima H, et al. Cigarette smoking, systolic blood pressure, and cardiovascular diseases in the Asia-Pacific region. Stroke. 2008;39(6):1694-702.
[26] Ge Z, Hao Y, Cao J, Li J, Chen J, Huang J, et al. Does cigarette smoking exacerbate the effect of blood pressure on the risk of cardiovascular and all-cause mortality among hypertensive patients? J Hypertens. 2012;30(12):2307-13.
[27] Tsukinoki R, Murakami Y, Huxley R, Ohkubo T, Fang X, Suh I, et al; Asia Pacific Cohort Studies Collaboration. Does body mass index impact on the relationship between systolic blood pressure and cardiovascular disease?: meta-analysis of 419 488 individuals from the Asia pacific cohort studies collaboration. Stroke. 2012;43(6):1478-83.
[28] Li K, Yao C, Yang X, Di X, Li N, Dong L, et al. Body Mass Index and the Risk of Cardiovascular and All-Cause Mortality Among Patients With Hypertension: A Population-Based Prospective Cohort Study Among Adults in Beijing, China. J Epidemiol. 2016;26(12):654-660.
[29] Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Di Angelantonio E, et al. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. J Hypertens. 2014;32(6):1170-7.
[30] Geldsetzer P, Manne-Goehler J, Theilmann M, Davies JI, Awasthi A, Danaei G, et al. Geographic and sociodemographic variation of cardiovascular disease risk in India: a cross-sectional study of 797,540 adults. PLoS medicine. 2018;15(6):e1002581.