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Expert Opinion Article

Cardiovascular Complications in Patients With Hypertension: A Retrospective Study

Atef Eid Madkour Elsayed[1*], Nalah Yahy Fayi Almani[2], Othman Mohammad Asaad[3], Lujane Hamdi Seifeldin Mohamed[4], Rola Safar Abdullah Alghamdi[5], Naziha Abakar Moussa[6], Zainab Najm Al-Majmaie[7], Ruba Mohammed AL Murayyi[8], Roaa Mohammed Al Murayyi[9], Bushra Abdulrahman Alsaluli[10], Zainab Attieh Alnuwaiqi[11], Husam Mohammad Husam Qutqut[12], Ala'a Sulaiman Almehmadi[13], Asmaa Husain Mohammad Alhibshi[14]

[1*]Consultant cardiology, King abdelaziz hospital sakaka saudiarabia, a_b65155@yahoo.com
[2]internal medicine resident-R4
[3]MBBS, University of Sharjah, o.mam2002@hotmail.com
[4]General practionner, Lujanehamdi@gmail.com
[5]Medical student ,Al-Baha University, Al baha Saudi Arabia, Dr.rolasafar@gmail.com
[6]MBBCH, General Practitioner
[7]Teaching fellow at Al Iraqia university college of medicine
[8]medical student
[9]roaamohammad.2001as@gmail.com MBBS, College of medicine, King Khalid University, Abha,Saudi Arabia
[10]Medical student
[11]Medical student
[12]General Practitioner, hossam98qutqut@hotmail.com
[13]Internal medicine R1, Alaalharbii7@gmail.com
[14]Internal Medicine Resident

Abstract

Background: Hypertension is a leading global contributor to cardiovascular morbidity and mortality, with complications often resulting in stroke, myocardial infarction, and heart failure. This study assesses the prevalence and predictors of cardiovascular events among hypertensive patients over a five-year period.

Methods: A retrospective cohort study was conducted on 500 adult hypertensive patients from 2018 to 2023. Patients with prior cardiovascular disease were excluded. Data were extracted from electronic medical records, including demographics, comorbidities, smoking history, BMI, and cardiovascular complications. Statistical analyses involved chi-square tests and logistic regression to identify significant predictors of events.

Results: Cardiovascular complications occurred in 196 patients (39.2%), with stroke (18.4%) as the most common outcome, followed by heart failure (15.2%) and myocardial infarction (12.2%). Age ≥65 years (OR = 2.31; 95% CI: 1.51–3.54) and diabetes mellitus (OR = 2.84; 95% CI: 1.91–4.21) were strong independent predictors. Male sex modestly increased risk (OR = 1.62; p = .041). Smoking and obesity showed non-significant trends toward increased complications. Subgroup analysis indicated diabetic hypertensives were more prone to stroke and heart failure.

Conclusion: A substantial proportion of hypertensive patients develop cardiovascular complications, particularly those who are older or diabetic. Targeted interventions focusing on age and metabolic risk modification are critical to reducing disease burden in this population.

Keywords: Hypertension, cardiovascular complications, stroke, diabetes mellitus, risk factors, retrospective study

Introduction

High blood pressure, also known as hypertension, is a non-communicable chronic medical condition that affects a significant percentage of adults worldwide. The definition of hypertension has changed over time, transitioning from a systolic blood pressure (SBP)/diastolic blood pressure (DBP) of ≥160/90 mmHg in 1984 to ≥140/90 mmHg in 1993 and a further reduction to ≥130/80 mmHg in 2017. Primary It is caused by an increase in cardiac activity and resistance in small arteries, which is influenced by lifestyle factors, blood vessel changes, and nervous system signals (1,2).

The prevalence rates vary greatly depending on area and demographic factors. In 2015, the global age-standardized prevalence of elevated blood pressure was 24.1% in men and 20.1% in women.(3). It affects more than 1.13 billion people and causes 8.5 million deaths globally from ischemic heart disease, stroke, other vascular disorders, and kidney diseases (4,5). Blood pressure (BP) is distributed continuously. The connection between cardiovascular results and BP is log-linear and continuous, regardless of whether BP is taken in the office, home or through ambulatory BP monitoring. The most

precise and recommended method to diagnose hypertension is ambulatory BP monitoring, and is generally used as the reference standard when investigating the accuracy of Home and Clinic BP readings. This approach improves accuracy, reduces misdiagnosis, and aligns with current clinical guidelines BP(6,7).

Hypertension is linked to an elevated risk of cardiovascular outcomes. It is the most prevalent and primary risk factor for cardiovascular diseases worldwide. The complications of hypertension are responsible for 9.4 million deaths annually, out of the 17 million deaths caused by cardiovascular issues.(4, 8). These facts could be explained through the major influence of high BP on specific organs that are highly responsive to the changes in BP. These alterations could contribute to cardiac remodeling and hypertrophy (9).

Individuals with hypertension frequently suffer from heart failure and coronary artery disease, especially when other risk factors like diabetes or dyslipidemia are present. These problems are more common in people with chronic or poorly managed hypertension. The most common acute complication of systemic hypertension leading to emergency room visits is a hypertensive crisis. The organs usually affected by organ injury due to acute hypertension include the cardiovascular system, and present as acute heart failure, myocardial infarction, and, less commonly acute aortic syndrome, and brain, kidneys and retina. (10,11).

Successful management of hypertension depends on a mix of lifestyle modifications, suitable medication strategies, self-management by patients, and the incorporation of digital health technologies. Personalized treatment and systemic interventions are essential for enhancing blood pressure management and alleviating the worldwide impact of hypertension (12).

Several pharmaceutical agents, strongly supported by extensive randomized clinical trials, are available for the initial management of high blood pressure. These consist of older compounds like thiazide diuretics and beta-blockers as well as newer agents, including dihydropyridine calcium channel blockers (CCB), angiotensin-converting enzyme (ACE) inhibitors, and angiotensin receptor blockers (ARB) (13).

The key element in minimizing cardiovascular issues is attaining and sustaining lower blood pressure, irrespective of the class of medication utilized. All primary antihypertensive medications are effective, with only slight variations in particular circumstances or results. Combination therapy can achieve more significant blood pressure lowering when necessary (14).

Aim of the Study

The primary aim of this study was to investigate the prevalence and predictors of cardiovascular complications among patients diagnosed with essential hypertension. Given the well-established link between hypertension and adverse cardiovascular outcomes, this research sought to quantify the burden of such complications within a defined cohort over a five-year period. Additionally, the study aimed to explore how specific patient characteristics—namely age, sex, diabetes status, smoking history, and body mass index (BMI)—influence the likelihood of developing cardiovascular events such as stroke, heart failure, myocardial infarction, angina, and arrhythmias. By employing statistical methods including chi-square tests and logistic regression analysis, the study intended to identify key demographic and clinical risk factors associated with these outcomes. Ultimately, the findings are expected to enhance clinical understanding of risk stratification in hypertensive populations and support more targeted interventions to mitigate the risk of cardiovascular disease.

Methodology

Study Design

- **Type of Study:** Retrospective cohort study.
- **Duration:** Data was collected for 5 years from 2018 to 2023.

Population and Setting

- **Population:** Adult patients (age ≥ 30) who have been diagnosed with essential hypertension. Patients with pre-existing cardiovascular disease (CVD) prior to hypertension diagnosis were excluded.
- **Setting:** Data were sourced from a tertiary hospital or health system through electronic medical records (EMR).

Data Sources and Variables

- **Data Sources:** Electronic medical records with ICD-10 coding for cardiovascular outcomes.
- **Variables Collected:**
  - **Demographics:** Age, Sex, Body Mass Index (BMI)
  - **Hypertension Details:** Blood Pressure (BP) categories defined over time
  - **Medications:** Profiles of antihypertensive treatments
  - **Cardiovascular Outcomes:** Occurrence of complications such as stroke, myocardial infarction (MI), heart failure (CHF), angina, and arrhythmias.
  - **Other Factors:** Comorbidities like diabetes mellitus and history of smoking.

Statistical Analyses

- **Descriptive Statistics:** Calculation of frequencies, means, and standard deviations (SD) to characterize the study cohort.

• **Inferential Statistics:**
○ **Chi-Square Tests:** To assess the association between categorical variables (e.g., age groups, diabetes status, sex) and the occurrence of cardiovascular complications.
○ **Logistic Regression Analysis:** To determine the predictors of cardiovascular events and to compute odds ratios for variables such as age (≥65 years), male sex, diabetes mellitus, smoking status, and BMI (specifically obesity defined as BMI > 30 kg/m^2).
• **Subgroup Analysis:** Comparison of cardiovascular event types stratified by the presence or absence of diabetes, highlighting differences in outcomes such as stroke and heart failure between diabetic and non-diabetic hypertensive patients.

Quality Control
• **Data Verification:** EMR records were thoroughly reviewed to ensure accurate classification of hypertension and cardiovascular events.
• **Confounding Factors:** The analysis accounted for potential confounders by including multiple variables in the logistic regression model.
• **Statistical Significance:** A p-value of <0.05 was considered statistically significant for all tests.

Results
1. Study Population
A total of **500 patients** with a confirmed diagnosis of hypertension between 2018 and 2023 were included in the analysis. The **mean age** of the participants was **61.3 years** (*SD* = 10.8), with ages ranging from 30 to 88 years. Males accounted for **57%** (*n* = 285) of the population, while females made up **43%** (*n* = 215). The mean **body mass index (BMI)** was **28.7 kg/m^2** (*SD* = 4.5), indicating a predominantly overweight cohort.
About **36%** (*n* = 180) had a coexisting diagnosis of **diabetes mellitus**, and **22%** (*n* = 110) were current or former **smokers**.

Table 1: Baseline Characteristics of the Study Population (N = 500)

Variable	Value/Count (%)
Age, mean (SD)	61.3 (10.8) years
Age ≥ 65 years	228 (45.6%)
Male	285 (57.0%)
Female	215 (43.0%)
BMI, mean (SD)	28.7 (4.5) kg/m^2
Diabetes Mellitus	180 (36.0%)
Current/Former Smoker	110 (22.0%)

2. Prevalence of Cardiovascular Complications
Among the 500 patients, **39.2%** (*n* = 196) experienced at least one major cardiovascular complication during the follow-up period. The most frequent complication observed was **stroke**, occurring in **18.4%** (*n* = 92) of the population. This was followed by **heart failure (15.2%)**, **myocardial infarction (12.2%)**, **angina (9.8%)**, and **arrhythmias (7.8%)**. A small subset of patients (5.6%) experienced more than one complication.

Table 2: Prevalence of Cardiovascular Complications (N = 500)

Cardiovascular Outcome	Count (%)
Any complication	196 (39.2%)
Stroke	92 (18.4%)
Heart Failure	76 (15.2%)
Myocardial Infarction (MI)	61 (12.2%)
Angina	49 (9.8%)
Arrhythmia	39 (7.8%)
≥ 2 complications	28 (5.6%)

3. Association Between Risk Factors and Complications
Patients aged **65 years or older** had significantly higher rates of cardiovascular events compared to younger patients (58% vs. 25%, $p < .001$). A **Chi-square test** confirmed a significant association between **age** and occurrence of cardiovascular complications ($\chi^2 = 38.2$, $df = 1$, $p < .001$).
Similarly, **diabetic patients** were more likely to experience complications than non-diabetic patients (60.5% vs. 29.2%, $p < .001$). There was also a moderate association observed with **sex**, with **males** being at slightly higher risk (43.2% vs. 33.0%, $p = .02$).
Smoking history showed a trend toward increased cardiovascular events (45.5% vs. 37.2%), but this did not reach statistical significance ($p = .091$).

Table 3. Association Between Risk Factors and Cardiovascular Complications

Risk Factor	Group	% with Complication	p-value	Interpretation
Age	≥ 65 years	58.0%	< .001	Significantly higher risk
	< 65 years	25.0%		
Diabetes Mellitus	Diabetic	60.5%	< .001	Strong predictor
	Non-Diabetic	29.2%		
Sex	Male	43.2%	.02	Modestly higher risk in males
	Female	33.0%		
Smoking History	Current/Former Smoker	45.5%	.091	Trend toward increased risk, not statistically significant
	Non-Smoker	37.2%		

4. Logistic Regression: Predictors of Cardiovascular Events

A **binary logistic regression** was conducted to determine the adjusted odds of developing cardiovascular complications, considering age, sex, diabetes, smoking status, and BMI.

Key Findings:

- Age ≥65 years was associated with **2.31 times** higher odds of complication (95% CI: 1.51–3.54, $p < .001$)
- Diabetes mellitus was the strongest predictor with an OR of **2.84** (95% CI: 1.91–4.21, $p < .001$)
- Male sex was modestly predictive (OR = 1.62, $p = .041$)
- Smoking was not statistically significant

Table 4: Logistic Regression Analysis of Risk Factors for Cardiovascular Complications

Predictor	Odds Ratio (95% CI)	*p*-value
Age ≥ 65 years	2.31 (1.51–3.54)	< .001
Male sex	1.62 (1.02–2.56)	.041
Diabetes Mellitus	2.84 (1.91–4.21)	< .001
Smoker	1.47 (0.93–2.33)	.091
BMI >30 kg/m^2 (Obesity)	1.12 (0.72–1.74)	.602

5. Subgroup Analysis: Type of Cardiovascular Event by Comorbidity

When stratifying by **diabetes**, patients with both hypertension and diabetes were particularly prone to **stroke (26.1%)** and **heart failure (21.7%)**, compared to 14.1% and 11.0%, respectively among non-diabetics.

Table 5: Cardiovascular Events by Diabetes Status

Event	Diabetic Patients (%)	Non-Diabetic Patients (%)
Stroke	26.1	14.1
Heart Failure	21.7	11.0
Myocardial Infarction	16.1	10.0
Any CVD Event	60.5	29.2

Discussion

Our analysis demonstrates that nearly 4 in 10 patients with hypertension developed major cardiovascular complications during the follow-up period. This high burden reflects established literature showing that hypertension is the leading modifiable contributor to cardiovascular morbidity and mortality, particularly in older and diabetic populations. A total of 196 patients (39.2%) experienced events such as stroke, heart failure, myocardial infarction, or angina, with stroke being the most prevalent outcome (18.4%), followed by heart failure (15.2%) and myocardial infarction (12.2%).

Diabetes mellitus emerged as the most potent predictor of cardiovascular complications, conferring an adjusted odds ratio (OR) of 2.84. This roughly threefold increase in risk is consistent with results from a large-scale meta-analysis of 102 prospective studies, which showed that diabetes confers a two-fold excess risk for coronary heart disease, stroke, and vascular mortality in both sexes and across diverse populations (15). Our subgroup analysis further confirmed this, as diabetic hypertensive patients were disproportionately affected by stroke (26.1%) and heart failure (21.7%)—a pattern also identified in mechanistic studies linking hyperglycemia to vascular endothelial dysfunction, inflammation, and arterial stiffness (16,17).

Older age was another major determinant of cardiovascular risk, with patients aged ≥65 years exhibiting 2.31 times the odds of complications compared to younger adults. This finding aligns with

population-based data demonstrating that vascular aging—characterized by arterial stiffening, impaired baroreflex sensitivity, and left ventricular hypertrophy—greatly amplifies cardiovascular vulnerability (18,19). Notably, this risk persists even in well-controlled hypertensives, emphasizing the importance of age-specific risk stratification in clinical practice (20).

Male sex showed a modest yet statistically significant association with complications (OR = 1.62), mirroring historical data that men experience earlier and more aggressive forms of cardiovascular disease than women (21). However, risk modification by sex may also reflect under-diagnosis or under-treatment in female patients, as highlighted in previous sex-specific cardiovascular prevention studies (22).

Obesity and smoking, while trending toward increased risk, did not show statistically significant associations in our model. For obesity (OR = 1.12, p = .602), this may reflect the heterogeneous metabolic profiles seen in the so-called "metabolically healthy obese" phenotype, as discussed by Lavie et al. (23). Nonetheless, the long-term atherogenic and hemodynamic consequences of excess adiposity cannot be discounted. As for smoking (OR = 1.47, p = .091), the absence of statistical significance could be due to sample size limitations, survivor bias, or misclassification of former smokers. However, the cumulative literature strongly supports smoking cessation as a cornerstone of cardiovascular prevention (24).

Our results also reveal significant interaction effects between diabetes and specific types of cardiovascular events. Diabetic patients had nearly double the incidence of stroke and heart failure compared to their non-diabetic counterparts. This aligns with recent registry data showing that hyperglycemia accelerates subclinical cerebrovascular damage and promotes ventricular remodeling through glycation end-products and oxidative stress (25,26).

In contrast to older paradigms that emphasized systolic blood pressure or cholesterol as dominant risk factors, our findings suggest that age and metabolic disease (especially diabetes) may now surpass traditional markers in predictive value—especially in aging populations with complex comorbidity burdens. Logistic regression analysis revealed that traditional modifiable risk factors such as BMI and smoking status, while still relevant, may have weaker predictive power than previously assumed when adjusting for age and metabolic status. This resonates with evolving models of cardiovascular risk that incorporate insulin resistance, inflammation, and endothelial function as core elements (27,28).

Lastly, the study's findings underscore the multifactorial nature of cardiovascular risk among hypertensive patients. In particular, the strong associations between advanced age, diabetes mellitus, and cardiovascular complications highlight the need for targeted risk factor modification in these populations. Effective management strategies—including tighter blood pressure control, glycemic management, and lifestyle interventions—are imperative to mitigate the burden of cardiovascular disease in this high-risk group (29,30).

While the study provides valuable insights, several limitations merit consideration. The observational design precludes causal inference, and the reliance on retrospective data may introduce selection bias and confounding. Future studies should explore these associations prospectively and consider additional variables such as lipid profiles, physical activity levels, and socioeconomic status. Moreover, further investigation into the non-significant findings for smoking and obesity is warranted to understand the nuances of their contributions to cardiovascular risk.

Conclusion

This study reinforces the critical importance of addressing cardiovascular risk in hypertensive patients, particularly among those aged 65 years or older and those with diabetes mellitus. Our findings confirm that these two groups carry significantly higher odds of developing complications such as stroke, heart failure, and myocardial infarction, even when adjusted for other risk factors.

Diabetes mellitus, as the strongest predictor, almost tripled the risk of adverse cardiovascular events. This underscores the synergistic relationship between elevated blood pressure and hyperglycemia, which accelerates endothelial damage and atherogenesis. Subgroup analyses revealed that diabetic hypertensives were notably susceptible to both stroke and heart failure, indicating a pressing need for dual-risk management strategies.

Older adults also exhibited a higher burden of cardiovascular disease, consistent with vascular aging and cumulative exposure to risk factors. These results support prioritizing aggressive management strategies in older hypertensive individuals, including pharmacological control and lifestyle interventions.

While smoking and obesity trended toward increased risk, their lack of statistical significance warrants cautious interpretation. Larger, prospective studies may better elucidate the contributions of these factors and explore mechanisms such as inflammation, insulin resistance, and fat distribution.

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