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ORIGINAL ARTICLE

Characterization of hypertensive patients admitted due to cardiovascular complications

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ABSTRACT

Introduction: arterial hypertension is the most important modifiable risk factor for atherosclerosis-related diseases.
Objectives: to identify the clinical, radiological, humoral, and electrocardiographic characteristics of hypertensive patients admitted due to cardiac and cerebrovascular complications.
Methods: an observational, descriptive, cross-sectional study was conducted with hypertensive patients admitted to the Internal Medicine wards of the National Hospital "Guido Valadares" in Timor-Leste between February and May 2024, diagnosed with acute coronary syndrome, heart failure, or stroke. Document review of medical records provided the data for the analyzed variables, using descriptive statistical methods.
Results: the median age was 63 years (IQR: 53–72), with a slight female predominance (50,9 %). The most frequent risk factor was dyslipidemia (67,3 %), primarily elevated LDL cholesterol. Cardiomegaly was present in 80,0 % of patients, and the most common electrocardiographic marker of myocardial damage was left ventricular hypertrophy (38,2 %).
Conclusions: advanced age, dyslipidemia with elevated LDL cholesterol, cardiomegaly, and left ventricular hypertrophy were the most frequent characteristics among hypertensive patients admitted for cardiovascular complications. No significant differences were observed between types of cardiovascular complications studied.

keywords: Atherosclerosis; Cardiovascular Diseases; Heart Disease Risk Factors; Hypertension; Cerebrovascular Disorders.

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INTRODUCTION

Arterial hypertension is the most important modifiable risk factor for atherosclerosis-related diseases.[1] This has been demonstrated since the earliest large population-based studies, particularly from the mid-20th century onward. The Framingham Study, after decades of patient follow-up, continues to identify arterial hypertension as one of the four major atherosclerotic risk factors, alongside diabetes, smoking, and dyslipidemias.

Hypertension is the most prevalent disease worldwide, with an estimated 1.3 billion affected individuals.[2] Hypertension leads to atherosclerosis and other vascular pathologies by damaging the endothelium and muscular layer of arteries. This accelerates atherosclerotic plaque formation and causes hypertrophy and fibrosis of the muscular layer, regardless of vessel lumen diameter. Such vascular pathology—whether atherosclerotic or non-atherosclerotic—can cause ischemic cerebrovascular disease, retinopathy, coronary artery disease, and chronic kidney disease in small arteries and arterioles. In medium and large arteries, it may lead to aneurysmal dilatation, arterial rupture (massive hemorrhage), and peripheral occlusive disease. Moreover, sustained hypertension increases left ventricular afterload, ultimately resulting in hypertensive heart disease. This serious complication begins with concentric left ventricular remodeling, progresses to concentric hypertrophy, and eventually causes diastolic and systolic dysfunction, leading to various forms of heart failure.[1]

Cardiovascular diseases are the leading cause of death in most countries worldwide, occasionally surpassed only by cancer. Therefore, the relationship between hypertension and cardiovascular diseases is especially significant, as proper understanding enables more precise management of the primary causes of global morbidity and mortality. Thus, this study was conducted with the objective of identifying the clinical, radiological, humoral, and electrocardiographic characteristics of hypertensive patients admitted due to cardiac and cerebrovascular complications.

METHODOLOGY

An observational, descriptive, cross-sectional study was conducted with hypertensive patients consecutively admitted for heart failure, acute coronary syndrome, or stroke to the Internal Medicine wards of the National Hospital "Guido Valadares" in Timor-Leste between February and May 2024. In all cases, diagnosis was confirmed by the corresponding specialist—either a cardiologist or neurologist—based on appropriate imaging studies (echocardiogram, electrocardiogram, or brain multidetector CT, as applicable).

Population and sample: From a universe of 66 patients, 55 were selected using non-probabilistic purposive sampling, after verifying compliance with selection criteria:

- Inclusion criteria: Patients aged >18 years with a known history of arterial hypertension or persistently elevated blood pressure during hospitalization, and with complete clinical records providing data relevant to the study objectives.
- Exclusion criteria: Patients whose cardiovascular complication was more likely due to infectious diseases or non-atherosclerotic conditions (e.g., infective endocarditis, severe sepsis, extrapulmonary tuberculosis, advanced HIV, rheumatic heart disease, rheumatoid arthritis, systemic lupus erythematosus, etc.). Patients with identifiable secondary causes of hypertension were also excluded.

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Study design

Patients were assigned to one of two mutually exclusive groups based on their final discharge diagnosis. The first group included patients with congestive heart failure (due to systolic or diastolic dysfunction; N=15) and those with acute coronary syndrome with or without persistent ST-segment elevation (N=15), collectively defined as "Cardiac Disease" (N=30). The second group comprised patients with cerebrovascular disease—either ischemic (N=18) or hemorrhagic (N=7)—defined as "Cerebrovascular Disease" (N=25).

Initially, the clinical, radiological, humoral, and electrocardiographic characteristics of all patients were described. Subsequently, statistical tests were used to compare the distribution of these characteristics between groups to address the study's secondary objective.

Data collection methods: After reviewing medical records, data were collected through direct observation. Study variables (age, sex, cardiovascular risk factors, radiological findings on chest X-ray, laboratory results, and admission electrocardiogram) were recorded on a data collection form and entered into a database created in Excel 2016 for analysis.

Statistical analysis: Qualitative variables were summarized using absolute frequencies and percentages. Statistical significance of differences between groups was assessed using the chi-square test or Fisher's exact test. Quantitative variables were summarized as median and interquartile range (IQR), and between-group differences were evaluated using the Kruskal-Wallis H test. Statistical analysis was performed using Jamovi® software, version 2.3.28. Statistical significance was set at $p < 0.05$.

Ethical considerations: This research complied with ethical regulations for human and clinical studies in accordance with the Declaration of Helsinki. Approval was obtained from the hospital's Scientific Council and Ethics Committee. Patient identities were protected, and all data were used exclusively for scientific purposes and disseminated in reputable conferences or journals.

RESULTS

As shown in Table 1, there was a slight female predominance (50,9 %), more pronounced in the cerebrovascular disease group (64,0 %), although the difference was not statistically significant compared to the cardiac disease group (Table 2). Regarding age, the most represented group in both categories was 50–59 years, with median ages of 63,5 and 63,0 years for cardiac and cerebrovascular patients, respectively.

ISSN: 1561-3194 **RNPS:** 1877
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Table 1. Baseline characteristics at admission of the study population.

Variable		No. (%)
Female		**28 (50,9)**
Age	<50 years	6 (10,9)
	50-59 years	17 (30,9)
	60-69 years	12 (21,8)
	70-79 years	13 (23,6)
	≥80 years	7 (12,7)
Risk Factors	Previous hospital admission due to cardiovascular disease	19 (34,5)
	Diabetes	16 (29,1)
	Smoking	20 (36,4)
	Dyslipidemia	37 (67,3)
	Abdominal obesity	21 (38,2)
Radiological Findings	Presence of cardiomegaly	44 (80,0)
	Cardi thoracic index*	0,58 (0,53-0,63)
	Presence of aortic plaque	22 (40,0)
Laboratory Values	Blood glucose (mmol/L)*	7,1 (5,13-9,88)
	Creatinine (µmol/L)*	81,7 (62,5-102)
	Estimated glomerular filtration rate (ml/min/1.73m^2)*,**	83 (65,8-96,3)
	Total cholesterol (mmol/L)*	4,7 (3,95-5,55)
	HDL cholesterol (mmol/L)*	1,14 (0,92-1,31)
	cholesterol (mmol/L)*	2,64 (2,01-3,16)
	LDL Triglycerides (mmol/L)*	1,48 (1,0-1,92)
Electrocardiogram Abnormalities	Left ventricular hypertrophy	21 (38,2)
	Left atrial enlargement	16 (29,1)
	Left anterior fascicular block	9 (16,4)
	Left bundle branch block	5 (9,1)
	Nonspecific ventricular repolarization abnormalities	47 (85,5)
	Prolonged QTc interval	36 (65,5)
	QTc (ms)*	486 (446-543)
	Atrial fibrillation	9 (16,4)

Notes: *Median (Interquartile range); **Calculated using the CKD-EPI formula

ISSN: 1561-3194 **RNPS:** 1877
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Table 2. Distribution of patients according to demographic variables.

Studied variable		Cardiac disease	Cerebrovascular disease	p Valor
Female		12 (40,0)	16 (64,0)	0,076
Age	<50 years	3 (10,0)	3 (12,0)	0,932
	50-59 years	9 (30,0)	8 (32,0)	
	60-69 years	6 (20,0)	6 (24,0)	
	70-79 years	7 (23,3)	6 (24,0)	
	≥80 years	5 (16,7)	2 (8,0)	

The most prevalent risk factor was dyslipidemia (67,3 %), followed by abdominal obesity (38,2 %) (Table 1). Among cardiac patients, recurrent hospital admissions due to cardiovascular causes, active smoking, and obesity were more frequent, whereas diabetes and dyslipidemia were more common in the stroke group (Table 3). However, no statistically significant differences in prevalence were found for any of the risk factors studied. Only in 4 cardiac patients (13,3 %) and 1 cerebrovascular patient (4,0 %) were no additional risk factors identified beyond arterial hypertension.

Table 3. Distribution of patients according to the presence of risk factors.

Variable	Cardiac disease	Cerebrovascular disease	p-value
Previous admission due to cardiovascular disease	12 (40,0)	7 (28,0)	0,351
Diabetes	8 (26,7)	8 (32,0)	0,665
Smoking	11 (36,7)	9 (36,0)	0,959
Dyslipidemia	20 (66,7)	17 (68,0)	0,916
Abdominal Obesity	14 (46,7)	7 (28,0)	0,156

Most of the studied patients presented abnormalities in cardiac silhouette on chest X-ray. 80,0 % exhibited cardiomegaly, with a median cardiothoracic index (CTI) of 0,58. Additionally, 40,0 % had aortic plaque at the time of the study (Table 1). The cardiac disease group showed a higher prevalence of cardiomegaly (86.7%) and higher CTI values (median 0,59; IQR: 0,55–0,65), whereas patients with stroke showed a higher frequency of aortic plaque (48,0 %) (Table 4). However, none of these differences reached statistical significance.

Table 4. Distribution of patients according to radiological findings on chest X-ray.

Variable	**Cardiac disease**	**Cerebrovascular disease**	**p-value**
Presence of cardiomegaly	26 (86,7)	18 (72,0)	0,176
Cardiothoracic index	0,59 (0,55–0,65)	0,55 (0,48–0,60)	0,051
Presence of aortic plaque	10 (33,3)	12 (48,0)	0,269

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(2025): e6623

Regarding laboratory results, both groups exhibited a similar metabolic profile (Table 5). The most notable differences were higher creatinine levels and lower estimated glomerular filtration rate (eGFR) in patients with cardiac disease, as well as higher total and LDL cholesterol levels in the cerebrovascular disease group. Statistically significant differences were found only in HDL cholesterol levels, which were significantly higher in the cerebrovascular group.

Table 5. Distribution of patients according to laboratory values at admission.

Variable	Cardiac disease	Cerebrovascular disease	p-value
Blood glucose (mmol/L)	7,13 (5,34–10,28)	7,10 (4,92–9,20)	0,472
Creatinine (µmol/L)	86,4 (69,82–100,5)	76,55 (55,9–100,0)	0,141
Estimated glomerular filtration rate (mL/min/1.73m²)	80,5 (61,25–94,0)	83,0 (69,25–100,0)	0,399
Total cholesterol (mmol/L)	4,4 (3,3–5,2)	5,05 (4,2–5,6)	0,205
HDL cholesterol (mmol/L)	1,1 (0,84–1,17)	1,25 (1,0–1,6)	**0,024**
LDL cholesterol (mmol/L)	2,51 (1,81–3,02)	2,84 (2,29–3,5)	0,382
Triglycerides (mmol/L)	1,58 (1,17–1,91)	1,32 (0,9–2,19)	0,408

The most frequent electrocardiographic abnormalities were nonspecific ventricular repolarization disturbances (85,5 %) and QTc interval prolongation (65,5 %). Among the studied markers of structural damage, left ventricular hypertrophy was the most common (38,2 %). Patients with cardiac disease more frequently presented left atrial enlargement, left anterior fascicular block, left bundle branch block, and atrial fibrillation, whereas patients with stroke exhibited a higher prevalence of left ventricular hypertrophy. However, none of these differences reached statistical significance, with the largest (non-significant) difference observed for left bundle branch block (p = 0.362).

Table 6. Distribution of patients according to major electrocardiogram abnormalities.

Variable	Cardiac disease	Cerebrovascular disease	p-value
Left ventricular hypertrophy	11 (36,7)	10 (40,0)	0,800
Left atrial enlargement	10 (33,3)	6 (24,0)	0,448
Left anterior fascicular block	5 (16,7)	4 (16,0)	1,000
Left bundle branch block	4 (13,3)	1 (4,0)	0,362
Nonspecific ventricular repolarization abnormalities	27 (90,0)	20 (80,0)	0,446
Prolonged QTc interval	19 (63,3)	17 (68,0)	0,717
QTc (ms)	481 (453–545)	498 (445–529)	0,912
Atrial fibrillation	6 (20,0)	3 (12,0)	0,487

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DISCUSSION

Cardiovascular risk factors are classified as non-modifiable and modifiable. Among the former, the most relevant are advanced age, male sex or postmenopausal status, and a family history of premature cardiovascular disease (before age 55 in men and before age 65 in women). Other non-modifiable factors include low birth weight, genetic defects, and early menopause. [1]

Generally, men are more predisposed to cardiovascular diseases—a finding consistent with most reviewed studies.[3,4,5] The protective physiological effect of estrogens during women's reproductive years (higher HDL cholesterol and lower LDL levels) delays the onset of these complications by 7–10 years. After menopause, cardiovascular incidence accelerates exponentially in women,[1] resulting in similar prevalence rates between sexes at older ages. Additionally, smoking, alcohol consumption, and high salt intake are more prevalent among men across all age groups.

In our study, the population had low educational levels and limited access to healthcare, often seeking medical attention only at advanced disease stages or when complications required hospitalization. This context explains the nearly equal gender distribution observed.

Aging naturally leads to autonomic dysregulation, arterial and myocardial stiffness, subendothelial lipid plaque formation, and the cumulative negative impact of lifestyle factors and comorbidities—all directly linked to the onset and progression of cardiovascular diseases. Most reviewed studies report mean ages between 60–69 years, [5,6] though this may be higher in high-income countries with advanced health systems,[7] or lower in economically disadvantaged regions. [3,8]Our findings align with this literature.

However, as with all non-communicable chronic diseases, modifiable risk factors are the most critical, as they can be addressed through effective pharmacological or non-pharmacological interventions to alter disease trajectory. These include lifestyle-related factors such as overweight, obesity, physical inactivity, smoking, excessive alcohol consumption, diets high in cholesterol, saturated fats, calories, or sodium. Other modifiable risks include obstructive sleep apnea, hormonal contraceptives, cancer chemotherapy agents, anti-inflammatory drugs (steroidal or non-steroidal), chronic stress, and low socioeconomic status.[1]

Hypertension is the most easily identifiable treatable risk factor for stroke, myocardial infarction, heart failure, peripheral vascular disease, aortic dissection, atrial fibrillation, and end-stage nephropathy. It carries a high attributable risk fraction for cardiovascular complications, fatal outcomes, and disability.[9] This risk correlates with blood pressure levels and is independent of other risk factors,[2] though it is amplified in their presence—particularly diabetes, elevated LDL cholesterol, and smoking—or in the presence of subclinical disease.[1]

The high prevalence of dyslipidemia and obesity observed reflects the lifestyle patterns of the studied population, characterized by increased consumption of processed foods (rich in trans and saturated fats and sodium), sugary beverages, physical inactivity, and environmental pollution. In our series, dyslipidemia prevalence exceeded that reported in other studies, although other risk factors were comparable. For instance, a 2024 Turkish prospective study of 3,157 patients admitted for cardiovascular emergencies reported 59 % hypertension, 37,5 % diabetes mellitus, 35,5 % hyperlipidemia, and 34,6 % smoking.[10] In Cuba, a study of 106 patients with coronary syndrome found 35.8% smokers, 30.2% hypertensive, and 13.2% diabetic.[7]

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Rev Ciencias Médicas. 2025; 29(2025): e6623

Nonetheless, other reports also describe high dyslipidemia rates. A 2019 Thai study of 140,557 type 2 diabetics found an 88.,9 % dyslipidemia prevalence, associated with female sex (HR: 1,47; 95 % CI: 1,38–1,56), age <50 years (HR: 1,16; 95 % CI: 1,10–1,22), and obesity (HR: 1,23; 95 % CI: 1,16–1,31).[11] Similarly, a 2020 U.S. case-control study of 449 stroke patients identified dyslipidemia in 88,0 % (hypertension: 89,3 %, diabetes: 42,8 %, smoking: 37,0 %).[4]

Despite its limited statistical performance, radiological cardiomegaly has long been considered an important heart failure marker. Although more precise methods now exist—echocardiography, CT, MRI, and nuclear imaging—chest X-ray remains a simple, accessible, low-risk tool that also identifies other risk markers, such as thoracic aortic calcified plaques, cardiac chamber enlargement, and pulmonary congestion.

Protruding aortic plaque is associated with higher future cardiac and cerebrovascular event risk, as it correlates statistically with plaque presence in other arterial beds. A 2024 Japanese study of 615 patients undergoing coronary angiography found 30,2 % had protruding aortic plaque; these patients were generally older, had more comorbidities, high-risk coronary plaque features (lipid core, intimal rupture), and higher rates of major adverse cardiac and cerebrovascular events—including all-cause mortality, non-fatal acute coronary syndromes, and stroke.[12] A 2023 Chinese study also found that, in patients initiating dialysis, elevated cardiothoracic index combined with aortic arch calcification significantly correlated with both cardiovascular and all-cause mortality.[13]

Hospital admission provides an optimal opportunity to detect risk factors, comorbidities, and complication markers. Renal dysfunction is a key comorbidity in cardiac patients, associated with increased risks of diastolic/systolic dysfunction, recurrent myocardial infarction, coronary angioplasty failure, valvular disease, arrhythmias, refractory hypertension, cerebrovascular disease, hemorrhage, and cardiovascular death.[14]

Conversely, structural heart disease is a common and significant risk factor in chronic kidney disease patients, as it reduces renal perfusion and induces unfavorable structural changes via neurohormonal activation (sympathetic nervous system, renin-angiotensin-aldosterone system). Approximately 20 % of patients starting hemodialysis have preexisting heart failure, and 80 % exhibit aortic sclerosis.[14]

There is no universally accepted explanation for why LDL cholesterol levels should differ between cardiac and cerebrovascular diseases. However, elevated lipid levels—particularly LDL >2,8 mmol/L—are linked to higher cardiovascular complication risks in both conditions.[1,2] A Chinese cohort study of 353 stroke patients found strong associations between high total cholesterol, high LDL, and high triglycerides with stroke (OR: 2,5–5,3).[15] Lipid disorders stem not only from poor dietary patterns but can also be exacerbated by smoking and alcohol consumption.

Nonspecific ventricular repolarization abnormalities and QTc prolongation are nonspecific electrocardiographic changes that may occur in both cardiac and extracardiac conditions, resulting in poor diagnostic performance for identifying structural heart disease. In our study, no significant differences were observed between groups. However, patients with heart failure or acute coronary syndrome exhibited more repolarization abnormalities—likely due to underlying structural heart disease—while cerebrovascular patients showed greater QTc prolongation, possibly related to autonomic nervous system dysregulation commonly seen in stroke.

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(2025): e6623

Left ventricular hypertrophy (LVH) is the most studied target organ damage marker in hypertension, though its association with cardiovascular complications varies widely. In a prospective study of patients >65 years (mean age 72,9±5,8; 47,5 % male), strain pattern (HR: 1,93; 95 % CI: 1,160–3,196) and complete left bundle branch block (HR: 2,27; 95 % CI: 1,040–4.956) were independent predictors of major cardiovascular events (mortality, myocardial infarction, stroke, heart failure hospitalization), but LVH by Sokolow and Cornell criteria was not.[16]

However, the PARAGON-HF echocardiographic registry (1,097 patients; mean age 74±8; 53 % female) found 21 % LVH and 83 % left atrial enlargement prevalence, with LVH independently associated with subsequent heart failure hospitalization or cardiovascular death (HR: 1,05; 95 % CI: 1,0–1,1), unlike left atrial enlargement.[17] A 2012 prospective analysis of 922 hypertensive patients from the LIFE study (4,8-year follow-up) demonstrated that those with LVH confirmed by both echocardiography and ECG had worse ejection fraction, aortic regurgitation, albuminuria, and coronary artery disease, along with higher heart failure hospitalization risk (HR: 4,29; 95 % CI: 1,26–14,65). [18]

A 2020 meta-analysis of 58,098 patients showed increased stroke risk in those with LVH—higher with Cornell criteria positivity (HR: 1,63; 95 % CI: 1,38–1,93) and slightly lower with Sokolow criteria (HR: 1,42; 95 % CI: 1,20–1,69). [19] Another 2020 meta-analysis of 41,870 patients from nine studies confirmed higher major cardiovascular event risk in hypertensives with LVH: HR 1,30 (95 % CI: 1,01–1,66) for Sokolow and HR 1,33 (95 % CI: 1,20–1,47) for Cornell voltage criteria.[20]

CONCLUSIONS

Upon completion of this research, we concluded that advanced age, dyslipidemia with elevated LDL cholesterol, cardiomegaly, and left ventricular hypertrophy were the most frequent characteristics among hypertensive patients admitted for cardiovascular complications. However, among the studied patients, few clinical, radiological, humoral, or electrocardiographic features showed significant association with either cardiac or cerebrovascular complications.

Conflict of Interests

The authors declare no conflicts of interest or ethical concerns.

Author Contributions and Funding

WAMP: conceptualization, literature search, methodology, project administration, data collection, data curation, formal analysis, visualization, original draft writing. **RGMS:** conceptualization, supervision, review and editing of the original draft. **RMPG:** literature search, data collection.

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