# *Cardiac Assessments in Patients with Acute Ischemic Stroke Referred to Ahvaz Golestan Hospital in the Second Half of 2022*

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*ABSTRACT*

***Background and Objective:*** *Ischemic stroke is closely associated with cardiovascular diseases. The goal of this study was to assess cardiac conditions in patients with acute ischemic stroke referred to Golestan Medical Center in Ahvaz.*
***Methods:*** *This cross-sectional study included all patients with ischemic stroke referred to Golestan Hospital during six months (October to March 2022). Demographic information, clinical history, and stroke causes were gathered. Cardiac assessments were performed through routine and serial ECGs, Holter monitoring for heart rhythm, and echocardiography.*
***Results:*** *The incidence of hypertension, diabetes, and smoking was significantly higher in men than in women (P<0.05). Among the etiological factors based on the TOAST classification, the most common were large artery atherosclerosis and strokes of unknown origin. The highest frequency of sinus rhythm, an ejection fraction between 45-55%, and mild left ventricular hypertrophy were found, with these factors more prevalent in men. Atrial fibrillation was found in 145 patients (22.5%), while the rest had sinus rhythm. The most frequent cardiac issues were seen in men, in the 61-80 age group, among those with large artery atherosclerosis, and in those with hypertension as a risk factor. Statistically significant differences in heart rhythm, ejection fraction, left ventricular hypertrophy, and left atrial enlargement were noted between men and women, different age groups, and various stroke causes (P<0.05).*
***Conclusion:*** *The occurrence of cardiac issues in this study was notably high among stroke patients. Cardiac evaluations for ischemic stroke patients at hospitals should be enhanced.*

Keywords: *Ischemic stroke, cardiac assessments, stroke etiology*

## INTRODUCTION

*Stroke is the primary cause of long-term severe disability and the third leading cause of death in developed countries (1). Each year, over 5 million people die from stroke, and 1 in 6 survivors will suffer another stroke within 5 years, with most cases occurring in the first year (2, 3). Non-modifiable stroke risk factors include advanced age, male sex, racial background, and family history (4). Additional causes of ischemic stroke include cardiovascular conditions (such as atrial fibrillation (AF), other heart arrhythmias, heart failure, and coronary artery disease), paradoxical embolism from a patent foramen ovale (PFO), cervical artery dissection, infectious or inflammatory vasculitis, and systemic clotting disorders.*
*Atrial fibrillation (AF) is the leading cause of cardioembolic stroke. Studies show that individuals with AF are nearly six times more likely to experience a stroke than those of the same age with a normal heart rhythm, and the stroke risk increases significantly in the presence of rheumatic valve disease. In AF patients, stroke-related risk factors include advanced age, female sex, high blood pressure, diabetes, congestive heart failure, a history*

*of prior stroke or TIA, and signs of atherosclerotic disease (5). Cardioembolic strokes typically result in poorer outcomes than other stroke types due to increased morbidity and mortality rates, as well as early and prolonged recurrence (6).*

*Most cryptogenic strokes exhibit embolic characteristics, but there is no evidence of carotid disease, proximal vessel abnormalities, intracardiac thrombosis, or other causes, leading to their classification as embolic strokes of undetermined source (ESUS). Around 10 to 20 percent of these patients experience an AF episode during prolonged cardiac monitoring (7). Identifying the underlying causes of cardioembolic stroke is a vital aspect of the urgent assessment in acute ischemic stroke patients, as cardiac-related causes generally require a different treatment strategy, such as anticoagulant therapy, unlike the standard ischemic stroke treatment, which focuses on managing risk factors and using antiplatelet drugs (8).*

*Cardiac complications after a stroke are clinically termed "Stroke-Heart Syndrome" (SHS) and result from various pathophysiological mechanisms known as "Stroke-Induced Heart Injury" (SIHI) (9, 10, 11). This syndrome includes a broad spectrum of cardiac alterations, such as clinical, ECG, echocardiographic, biological, and morphological changes, which occur within the first 30 days following a stroke, especially in the initial days.*

*In every ischemic stroke patient, a standard ECG is crucial to check for atrial fibrillation or atrial flutter. Even if a patient has a known history of atrial fibrillation, an ECG is recommended to detect associated heart conditions like acute or chronic myocardial infarction (MI) and left ventricular hypertrophy. However, a standard ECG may not detect transient arrhythmias, so long-term heart rhythm monitoring is recommended for patients suspected of having a cardioembolic stroke. Long-term heart rhythm monitoring identifies atrial fibrillation more frequently than regular monitoring during hospitalization and is recommended for patients with cryptogenic stroke or embolic strokes of undetermined source (ESUS) (2). Most causes of cardioembolic stroke can be accurately identified through the patient's medical history, physical examination, lab tests, routine and serial ECGs, heart rhythm monitoring (telemetry in the hospital, Holter monitoring), and transthoracic echocardiography (TTE). Transesophageal echocardiography (TEE) is also highly valuable diagnostically and is essential when no cardiac source is identified in patients with cryptogenic stroke (12).*

*In 2005, Marini and colleagues in Italy evaluated the prevalence of atrial fibrillation (AF) and its impact on prognosis in patients experiencing their first ischemic stroke. Their analysis revealed that AF was an independent predictor of both 30-day and 1-year mortality, accounting for approximately 17% of all deaths. The study showed a high prevalence of AF in patients with their first ischemic stroke, particularly among elderly women, and it was associated with increased stroke-related mortality. This underlined the necessity for new strategies to prevent arrhythmias and more personalized treatments, especially for elderly women (13).In 2008, Douen and colleagues examined the role of serial ECG and Holter monitoring in identifying new cases of atrial fibrillation (AF) after a stroke. Their study demonstrated that performing serial ECGs within the first 72 hours of a stroke significantly enhanced the detection of AF (14).*

*In 2007, Liao and colleagues conducted a systematic review of 60 studies to evaluate the prevalence of undiagnosed atrial fibrillation/flutter that could be detected through continuous non-invasive heart monitoring after acute ischemic stroke or TIA. The findings from the reviewed studies indicated that the low detection rate of AF through Holter monitoring might be due to factors such as patient selection, timing of the monitoring, and the varying duration of monitoring. Early and prolonged monitoring of patients could potentially enhance detection rates (15).*

*In 2021, Poledník and colleagues conducted studies using the PubMed database to investigate coronary artery atherosclerosis and cardiovascular risk factors in patients with ischemic stroke or TIA. Their findings revealed that coronary plaques were present in 48-70% of ischemic stroke patients without a prior history of coronary artery disease (CAD), and significant stenosis in at least one coronary artery was observed in 31% of these patients. They concluded that CAD is a major contributor to complications and mortality in ischemic stroke patients, and diagnosing and treating asymptomatic CAD could improve the prognosis and survival of these individuals (16).*

*This study aimed to evaluate cardiac assessments and identify factors influencing the development of cardiac disorders in patients with acute ischemic stroke (AIS) who visited Golestan Hospital in Ahvaz. The research sought to explore cardiac disorders and various risk factors contributing to ischemic stroke in patients at the healthcare center, to aid in treatment decisions and reduce hospitalization duration by differentiating between types of cardiac disorders in ischemic stroke. Furthermore, the study aimed to decrease stroke-related morbidity and mortality and contribute to community prevention efforts using the collected data.*

***Research Methodology***

*This is a cross-sectional study, conducted after receiving the necessary approvals from the Research Council*

*and the Ethics Committee at the Research University of Jundi Shapur Ahvaz. The study included all patients who visited Golestan Hospital between October and March 2022 and were diagnosed with ischemic stroke based on their medical history, neurological examination, and imaging results. Non-random, consecutive sampling was employed for all patients with ischemic stroke during these six months, following the inclusion criteria, and data were collected from 644 eligible patients.*

*Inclusion criteria consisted of the patient's willingness to participate in the study, being over 18 years of age, and a diagnosis of ischemic stroke confirmed by medical history, neurological exams, and imaging findings by a specialist. Exclusion criteria included patients who were discharged before undergoing any necessary diagnostic or therapeutic procedures, patients diagnosed with cerebral venous sinus stroke, or those who died before completing the required diagnostic and therapeutic procedures.*

*Patients were admitted to various neurology departments for the required diagnostic and therapeutic procedures, and their data were recorded from admission to discharge. Once the stroke was confirmed through imaging, all patients underwent CT Angiography of the head and neck or carotid Doppler ultrasound. Additionally, all patients received cardiac evaluations, including ECG and transthoracic echocardiography (TTE). If needed, serial ECG, rhythm monitoring, Holter monitoring, transesophageal echocardiography (TEE), and contrast echocardiography were also performed.*

*In this study, after conducting the necessary diagnostic procedures, patients were classified according to the TOAST criteria. The TOAST classification system consists of five categories: 1) Large artery atherosclerosis, 2) Cardioembolic, 3) Small artery occlusion (such as lacunar infarction), 4) Stroke with other identified causes, and 5) Stroke with an unknown cause.*

*The data collection tool in this study was checklists designed by the researcher, containing information on ischemic stroke, demographic data, and the patient's clinical history.*

*Using the patient's medical history, risk factors, medical history extraction, and the results of the evaluations, the necessary data was collected and entered into SPSS version 24 for statistical analysis.*

***Findings***

*During the 6-month study period, 644 ischemic stroke patients referred to Golestan Hospital were eligible for participation. Among the participants, 363 were male and 281 were female. The average (standard deviation) age of the patients was 64.85 years, with a minimum age of 20 and a maximum age of 110 years. The average age for males was 63.95 years, while for females it was 66.04 years. Approximately 49% of the patients were between the ages of 61 and 80. Furthermore, the average age of females was statistically significantly higher than that of males (P<0.05).*

*The mean BMI of males and females was 26.41 kg/m² and 29.12 kg/m², respectively. About 74% of patients (n=477) were overweight, and 21.3% of patients (n=137) were obese. The mean BMI of females was statistically significantly higher than that of males (P<0.05).*

*Hypertension was the most common risk factor, affecting 443 patients (68.8%) of the 644 participants. Following hypertension in prevalence were diabetes (44.7%), ischemic heart disease (32.1%), smoking (28.7%), a history of stroke or TIA (27%), dyslipidemia (15.2%), coronary artery bypass surgery (CABG) (5%), and heart valve surgery (1.4%). The distribution of these risk factors is presented in Table (1). Hypertension, diabetes, and smoking were significantly more prevalent in males than females (P<0.05), whereas dyslipidemia was notably more common in females than males (P<0.05).*

***Table 1:*** *Frequency of Risk Factors Among Patients by Gender (n=644)*

| Variable | | Total (n=644) | Male (n=363) | Female (n=281) | P-value |
|---|---|---|---|---|---|
| | | Frequency (%) | | | |
| Hypertension | Yes | 443 (68/8) | 230 (63/4) | 213 (75/8) | *<0.05 |
| | No | 201 (31/2) | 133 (36/6) | 68 (24/2) | |
| Diabetes | Yes | 288 (44/7) | 147 (40/5) | 141 (52/2) | *<0.05 |
| | No | 356 (55/3) | 216 (59/5) | 140 (49/8) | |
| Dyslipidemia | Yes | 98 (15/2) | 38 (10/5) | 60 (21/4) | *<0.05 |
| | No | 546 (84/8) | 325 (89/5) | 221 (78/6) | |
| Smoking | Yes | 185 (28/7) | 143 (39/4) | 42 (14/9) | *<0.05 |

| | | | | | |
|---|---|---|---|---|---|
| | *No* | *459 (71/3)* | *220 (60/6)* | *239 (85/1)* | |
| *Ischemic heart disease* | *Yes* | *207 (32/1)* | *110 (30/3)* | *97 (34/5)* | *0.05>* |
| | *No* | *437 (67/9)* | *253 (69/7)* | *184 (65/5)* | |
| *Heart valve surgery* | *Yes* | *9 (1/4)* | *5 (1/4)* | *4 (1/4)* | *0.05>* |
| | *No* | *635 (98/6)* | *358 (98/6)* | *277 (98/6)* | |
| *Coronary artery bypass grafting (CABG)* | *Yes* | *32 (5)* | *18 (5)* | *14 (5)* | *0.05>* |
| | *No* | *612 (95)* | *345 (95)* | *267 (95)* | |
| *History of stroke or TIA (Transient Ischemic Attack)* | *Yes* | *174 (27)* | *94 (25/9)* | *80 (28/5)* | *0.05>* |
| | *No* | *470 (73)* | *269 (74/1)* | *201 (71/5)* | |

*Out of the patients with sinus rhythm, 172 underwent Holter monitoring. Among them, 126 patients had a 24-hour Holter, 37 had a 48-hour Holter, 6 had a 72-hour Holter, and 3 had a 96-hour Holter. Sinus rhythm was observed in 158 patients, while atrial fibrillation (AF) was detected in 14 patients (1.8%)—9 of whom were diagnosed with AF using the 24-hour Holter, and 5 with the 48-hour Holter. Table (2) presents the results regarding the frequency of cardiac disorders in 644 ischemic stroke patients by gender. The most common findings were sinus rhythm, ejection fraction between 45-55%, and mild left ventricular hypertrophy (LVH), with these conditions being more frequent in men. Half of the patients had an ejection fraction between 45-55%, and about one-third had mild LVH. Valve disorders were found in 95 patients (38 with mitral annular calcification [MAC], 45 with mitral valve prolapse [MVP], 6 with mitral stenosis [MS], and 6 with aortic valve stenosis [AVS]), left atrial enlargement (LAE) in 60 patients, and wall motion abnormalities (hypokinesia in 35 patients and aneurysm in 6 patients). Additionally, 10 patients had a patent foramen ovale (PFO) (8 with a shunt and 2 without), 8 had aortic plaques, and 4 had masses (3 with bacterial vegetation and 1 with a tumor). Statistically significant differences were found between men and women regarding the frequency of heart rhythm, ejection fraction, valve disorders, LVH, and LAE. However, no significant differences were observed for wall motion abnormalities (RWMA), PFO, and aortic plaques.*

***Table 2:*** *Frequency of Cardiac Disorders in Patients with Ischemic Stroke by Gender (n=644)*

| *Variable* | | *Total (n=644)* | *Male (n=363)* | *Female (n=281)* | *P-value* |
|---|---|---|---|---|---|
| *Cardiac Disorders* | | *Frequency (%)* | | | |
| *Rhythm* | *Sinus* | *499 (77/5)* | *283 (78)* | *216 (76/9)* | **<0.05* |
| | *Atrial Fibrillation (AF)* | *145 (22/5)* | *80 (22)* | *65 (23/1)* | |
| *EJECTION FRACTION* | *≥55%* | *64 (9/9)* | *41 (11/3)* | *23 (8/2)* | **<0.05* |
| | *45-55%* | *371 (57/6)* | *217 (59/8)* | *154 (54/8)* | |
| | *30-45%* | *120 (18/6)* | *36 (9/9)* | *84 (29/9)* | |
| | *<30%* | *89 (13/8)* | *69 (19)* | *20 (7/1)* | |
| *Heart Valve Disorders* | *Mitral Annular Calcification (MAC)* | *38 (5/9)* | *21 (5/8)* | *17 (6)* | **<0.05* |
| | *Mitral Valve Prolapse (MVP)* | *45 (7)* | *13 (4/6)* | *32 (11/4)* | |
| | *Mitral Stenosis (MS)* | *6 (0/9)* | *3 (0/8)* | *3 (1/1)* | |
| | *Aortic Valve Stenosis (AVS)* | *6 (0/9)* | *4 (1/1)* | *2 (0/7)* | |
| | *Other cases* | *391 (60/7)* | *222 (61/2)* | *169 (60/1)* | |
| | *Unknown* | *45 (7)* | *32 (8/8)* | *13 (4/6)* | |
| | *No* | *113 (17/5)* | *68 (18/7)* | *45 (16)* | |
| *Left* | *Mild* | *210* | *127 (35)* | *83* | **<0.05* |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Ventricular Hypertrophy (LVH)* | | | *(32/6)* | | *(29/5)* | |
| | *Moderate* | | *65 (10/1)* | *28 (7/7)* | *37 (13/2)* | |
| | *Severe* | | *37 (5/7)* | *5 (1/4)* | *32 (11/4)* | |
| | *Unknown* | | *73 (11/3)* | *38 (10/5)* | *35 (12/5)* | |
| | *No* | | *259 (40/2)* | *165 (45/5)* | *94 (33/5)* | |
| *Left Atrial Enlargement (LAE)* | *Yes* | | *60 (9/3)* | *26(7/2)* | *34 (12/1)* | **<0.05* |
| | *No* | | *584 (90/7)* | *337 (92/8)* | *247 (87/9)* | |
| *Regional Wall Motion Abnormalities (RWMA)* | *Aneurysm* | | *6 (0/9)* | *3 (0/8)* | *3 (1/1)* | *0.05>* |
| | *Hypokinesis* | | *35 (5/4)* | *19 (5/2)* | *16 (5/7)* | |
| | *No* | | *603 (93/6)* | *341 (93/9)* | *262 (93/2)* | |
| *Patent Foramen Ovale (PFO)* | *Yes* | *With shunt (n = 8)* | *10 (1/6)* | *6 (1/7)* | *)1/4 (4* | *0.05>* |
| | | *Without shunt (n = 2)* | | | | |
| | *No* | | *634 (98/4)* | *357 (98/3)* | *277 (98/6)* | |
| *Aortic Plaque* | *Yes* | | *8 (1/2)* | *5 (1/4)* | *3 (1/1)* | *0.05>* |
| *Mass* | *Bacterial Vegetation* | | *3 (0/5)* | *2 (0.6)* | *1 (0.4)* | *0.05>* |
| | *Tumor (Myxoma/Papillary Fibroelastoma)* | | *1 (0/2)* | *1 (0.3)* | *-* | |

***Table 3:*** *Frequency of Cardiac Disorders in Patients with Ischemic Stroke by Age Group (n=644)*

| *Variable* | | *Total (n=644)* | *20-40 years (n=26)* | *41-60 years (n=191)* | *61-80 years (n=321)* | *Over 80 years (n=106)* | *P-value* |
|---|---|---|---|---|---|---|---|
| *Cardiac Disorders* | | | *Frequency (%)* | | | | |
| *Rhythm* | *Sinus* | *499 (77/5)* | *26 (100)* | *173 (90/6)* | *246 (76/6)* | *54 (50/9)* | **<0.05* |
| | *Atrial Fibrillation (AF)* | *145 (22/5)* | *-* | *18 (9/4)* | *75 (23/4)* | *52 (49/1)* | |
| *EJECTION FRACTION* | *≥55%* | *64 (9/9)* | *8 (30/8)* | *30 (15/7)* | *21 (6/5)* | *5 (4/7)* | **<0.05* |
| | *45-55%* | *371 (57/6)* | *13 (50)* | *121 (63/4)* | *185 (57/6)* | *52 (49/1)* | |
| | *30-45%* | *120 (18/6)* | *2 (7/7)* | *22 (11/5)* | *65 (20/0)* | *31 (29/2)* | |
| | *<30%* | *89 (13/8)* | *3 (11/5)* | *18 (9/4)* | *50 (15/6)* | *18 (17)* | |
| *Heart Valve Disorders* | *Mitral Annular Calcification (MAC)* | *38 (5/9)* | *-* | *5 (2/6)* | *22 (6/9)* | *11 (10/4)* | **<0.05* |
| | *Mitral Valve Prolapse (MVP)* | *45 (7)* | *5 (19/2)* | *22 (11/5)* | *18 (5/6)* | *-* | |
| | *Mitral Stenosis (MS)* | *6 (0/9)* | *-* | *3 (1/6)* | *3 (0/9)* | *-* | |
| | *Aortic Valve Stenosis (AVS)* | *6 (0/9)* | *-* | *-* | *4 (1/2)* | *2 (1/9)* | |
| | *Other cases* | *391 (60/7)* | *9* | *140* | *217* | *25* | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | (34/6) | (73/3) | (67/6) | (23/6) | |
| | Unknown | 45 (7) | - | 10 (5/2) | 26 (8/1) | 9 (8/5) | |
| | No | 113 (17/5) | 12 (46/2) | 11 (5/8) | 31 (9/7) | 59 (55/7) | |
| Left Ventricular Hypertrophy (LVH) | Mild | 210 (32/6) | 6 (23/1) | 57 (29/8) | 105 (32/7) | 42 (39/6) | |
| | Moderate | 65 (10/1) | 2 (7/7) | 24 (12/6) | 30 (9/3) | 9 (8/5) | |
| | Severe | 37 (5/7) | 2 (7/7) | 11 (5/8) | 11 (3/4) | 13 (12/3) | *<0.05 |
| | Unknown | 73 (11/3) | 1 (3/8) | 5 (2/6) | 37 (11/5) | 30 (28/3) | |
| | No | 259 (40/2) | 15 (57/7) | 94 (49/2) | 13 8 (43) | 12 (11/3) | |
| Left Atrial Enlargement (LAE) | Yes | 60 (9/3) | - | 13 (6/8) | 32 (10) | 15 (14/2) | *<0.05 |
| | No | 584 (90/7) | 26 (100) | 178 (93/2) | 289 (90) | 91 (85/8) | |
| Regional Wall Motion Abnormalities (RWMA) | Aneurysm | 6 (0/9) | | 3 (1/6) | 2 (0/6) | 1 (0/9) | |
| | Hypokinesis | 35 (5/4) | - | 5 (2/6) | 21 (6/5) | 9 (8/5) | 0.05 > |
| | No | 603 (93/6) | 26 (100) | 183 (95/8) | 298 (92/8) | 96 (90/6) | |
| Patent Foramen Ovale (PFO) | Yes: with shunt (n=8) | 10 (1/6) | 4 (15/4) | 3 (1/6) | 3 (0/9) | - | 0.05 > |
| | Yes: Without shunt (n=2) | | | | | | |
| | No | 634 (98/4) | 22 (84/6) | 188 (98/4) | 318 (99/1) | 106 (100) | |
| Aortic Plaque | Yes | 8 (1/2) | | 3 (1/6) | 3 (0/9) | 2(1/9) | 0.05 > |
| Mass | Bacterial Vegetation | 3 (0/5) | - | 1 (0/5) | 2 (0/6) | - | 0.005> |
| | Tumor (Myxoma/Papillary Fibroelastoma) | 1 (0/2) | - | 1 (0/5) | - | - | |

*The results regarding the frequency of cardiac disorders in patients with ischemic stroke, categorized by age group, are reported in Table 3. The highest frequency of cardiac disorders based on classification was observed in the 61-80-year age group. The differences in frequency of rhythm, ejection fraction, left ventricular hypertrophy, valvular heart disorders, and left atrial enlargement (LAE) between different age groups were statistically significant (P<0.05). However, the differences in frequency of wall motion abnormalities (RWMA), patent foramen ovale (PFO), aortic plaques, and masses between age groups were not statistically significant.*

***Table 4**: Frequency of cardiac disorders in patients with ischemic stroke categorized by risk factors (n=644)*

| Variable | | Hypertension (n=443) | Diabetes (n=288) | Dyslipidemia (n=98) | Tobacco Use (n=185) | Previous Stroke or TIA History (n=174) |
|---|---|---|---|---|---|---|
| Cardiac disorders | | (%) Frequency | | | | |
| Rhythm | Sinus | 347 (78/3) | 234 (81/2) | )78/6 (77 | 141 (76/2) | 142 (81/6) |
| | Atrial fibrillation (AF) | 96 (21/7) | 54 (18/8) | 21 (21/4) | 44 (23/8) | 32 (18/4) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *EJECTION FRACTION* | *≥55%* | *25 (5/6)* | *13 (4/5)* | *3 (3/1)* | *11 (5/9)* | *11 (6/3)* |
| | *45-55%* | *246 (55/5)* | *192 (66/7)* | *65 (66/3)* | *122 (65/9)* | *109 (62/7)* |
| | *30-45%* | *98 (22/1)* | *52 (18)* | *22 (22/4)* | *35 (19)* | *31 (17/8)* |
| | *<30%* | *74 (16/8)* | *31 (10/8)* | *8 (8/2)* | *17 (9/2)* | *23 (13/2)* |
| *Valvular heart disorders* | *MAC or mitral annular calcification* | *30 (6/8)* | *21 (7/3)* | *6 (6/1)* | *12 (6/5)* | *11 (6/3)* |
| | *MVP or mitral valve prolapse* | *38 (8/6)* | *25 (8/7)* | *15 (15/3)* | *15 (8/1)* | *28 (16/1)* |
| | *MS or mitral stenosis* | *5 (1/1)* | *3 (1)* | *3 (3/1)* | *-* | *-* |
| | *AVS or aortic stenosis* | *6 (1/4)* | *1 (0/3)* | *2 (2)* | *-* | *3 (1/72)* |
| | *Other conditions* | *219 (49/4)* | *201 (69/8)* | *62 (63/3)* | *128 (69/2)* | *101 (58)* |
| | *Unspecified* | *40 (9)* | *21 (7/3)* | *10 (10/2)* | *10 (5/4)* | *16 (9/2)* |
| | *No* | *105 (23/7)* | *16 (5/6)* | *-* | *20 (10/8)* | *18 (10/4)* |
| *Left ventricular hypertrophy (LVH)* | *Mild* | *210 (47/4)* | *135 (46/9)* | *52 (53/1)* | *67 (36/2)* | *95 (54/6)* |
| | *Moderate* | *65 (14/7)* | *42 (14/6)* | *16 (16/3)* | *40 (21/6)* | *36 (20/7)* |
| | *Severe* | *37 (8/4)* | *16 (5/5)* | *13 (13/3)* | *17 (9/2)* | *20 (11/5)* |
| | *Unspecified* | *73 (16/5)* | *60 (20/8)* | *12 (12/2)* | *34 (18/4)* | *20 (11/5)* |
| | *No* | *58 (13)* | *35 (12/2)* | *5 (5/1)* | *27 (14/6)* | *3 (1/7)* |
| *Left atrial enlargement (LAE)* | *Yes* | *35 (8)* | *42 (14/6)* | *16 (16/3)* | *2 (1/1)* | *35 (20)* |
| | *No* | *408 (92)* | *246 (85/4)* | *82 (83/7)* | *183 (98/9)* | *139 (80)* |
| *Regional wall motion abnormalities (RWMA)* | *Aneurysm* | *1 (0/2)* | *1 (0/3)* | *1 (1)* | *3 (1/7)* | *-* |
| | *Hypokinesia* | *22 (5)* | *29 (10/1)* | *9 (9/2)* | *11 (5/9)* | *22 (12/6)* |
| | *No* | *420 (94/8)* | *258 (89/6)* | *88 (89/8)* | *171 (92/4)* | *152 (87/4)* |
| *Patent foramen ovale (PFO)* | *Yes* — *With shunt (n = 8)* / *Without shunt (n = 2)* | *3 (0/7)* | *3 (1)* | *2 (2)* | *)6/1. (3* | *-* |
| | *No* | *440 (99/3)* | *285 (99)* | *96 (98)* | *182 (98/4)* | *174 (100)* |
| *Aortic plaque* | *Yes* | *4 (0/9)* | *2 (0/7)* | *1 (1)* | *2 (1/1)* | *3 (1/7)* |
| *Mass* | *Bacterial vegetation* | *2 (0/5)* | *1 (0/3)* | *1 (1)* | *2 (1/1)* | *1 (0/6)* |
| | *Tumor (myxoma/papillary fibroelastoma)* | *-* | *-* | *1 (0/2)* | *1 (0/5)* | *-* |

***Table 5**: Frequency of cardiac disorders in patients with ischemic stroke categorized by risk factors (n=644)*

| ***Variable*** | | *Coronary Artery Disease (n=207)* | *Coronary Artery Bypass Grafting (CABG) (n=32)* | *Heart Valve Surgery (n=9)* |
|---|---|---|---|---|
| ***Cardiac disorders*** | | *(%) Frequency* | | |
| ***Rhythm*** | *Sinus* | *164 (79/2)* | *26 (81/2)* | *8 (88/9)* |
| | *Atrial fibrillation (AF)* | *43 (20/8)* | *6 (18/8)* | *1 (11/1)* |
| ***EJECTION*** | *≥55%* | *22 (20/8)* | *20(62/5)* | *1 (11/1)* |

| | | | | |
|---|---|---|---|---|
| ***FRACTION*** | *45-55%* | *109 (52/7)* | *1 (3/1)* | *4 (44/5)* |
| | *30-45%* | *45 (21/7)* | *8 (25)* | *3 (33/3)* |
| | *<30%* | *31 (15)* | *3 (9/4)* | *1 (11/1)* |
| ***Valvular heart disorders*** | *MAC or mitral annular calcification* | *19 (9/2)* | *2 (6/2)* | *-* |
| | *MVP or mitral valve prolapse* | *12 (5/8)* | *-* | *-* |
| | *MS or mitral stenosis* | *4 (1/9)* | *2 (6/2)* | *-* |
| | *AVS or aortic stenosis* | *4 (1/9)* | *2 (6/2)* | *-* |
| | *Other conditions* | *108(52/2)* | *5 (15/7)* | |
| | *Unspecified* | *20(9/7)* | *5 (15/7)* | *8 (88/9)* |
| | *No* | *40 (19/3)* | *18(56/2)* | *1(11/1)* |
| ***Left ventricular hypertrophy (LVH)*** | *Mild* | *120 (58)* | *13 (40/6)* | *2 (22/2)* |
| | *Moderate* | *46 (22)* | *8 (25)* | *4 (44/5)* |
| | *Severe* | *22 (10/6)* | *5 (15/6)* | *1 (11/1)* |
| | *Unspecified* | *12 (6)* | *6 (18/8)* | *-* |
| | *No* | *7 (3/4)* | *-* | *2 (22/2)* |
| ***Left atrial enlargement (LAE)*** | *Yes* | *45 (21/7)* | *3 (9/4)* | *2 (22/2)* |
| | *No* | *162 (78/3)* | *29 (90/6)* | *7 (77/8)* |
| ***Regional wall motion abnormalities (RWMA)*** | *Aneurysm* | *2 (1)* | *2 (6/2)* | *-* |
| | *Hypokinesia* | *18 (8/7)* | *-* | *-* |
| | *No* | *187 (90/3)* | *30 (93/8)* | *9 (100)* |
| ***Patent foramen ovale (PFO)*** | *Yes* | *2 (1)* | *-* | *-* |
| | *No* | *205 (99)* | *32 (100)* | *9 (100)* |
| ***Aortic plaque*** | *Yes* | *3 (1/4)* | *-* | *-* |
| ***Mass*** | *Bacterial vegetation* | *1 (0/5)* | *-* | *1 (11/1)* |
| | *Tumor* | *-* | *-* | *-* |

*The results related to cardiac disorders in patients with ischemic stroke, categorized by risk factors, are reported in Tables (4) and (5). The highest prevalence of cardiac disorders based on risk factors was observed in the group with hypertension as a risk factor. Following that, in descending order, were the groups with the risk factors of diabetes, ischemic heart disease, smoking, history of stroke or TIA, dyslipidemia, coronary artery bypass grafting (CABG), and heart valve surgery.*

***Table 6:*** *Frequency of Cardiac Disorders in Patients with Ischemic Stroke by Etiology (n=644)*

| *Variable* | | *(LAA) Large artery atherosclerosis (n=164)* | *(CE) Cardioembolic (n=155)* | *(SAO) Small artery obstruction (n=144)* | *(SOC) Stroke with other determined causes (n=21)* | *(SUC) Stroke with undetermined cause (n=160)* | *P-value* |
|---|---|---|---|---|---|---|---|
| *Cardiac Disorders* | | *(%) Frequency* | | | | | |
| *Rhythm* | *Sinus* | *159 (97)* | *18 (11/6)* | *141 (97/9)* | *21 (100)* | *160 (100)* | *05/0<** |
| | *Atrial Fibrillation (AF)* | *5 (3)* | *137 (88/4)* | *3 (2/1)* | *-* | *-* | *05/0<** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *EJECTION FRACTION* | *≥55%* | *14 (8/5)* | *5 (3/2)* | *10 (6/9)* | *7 (33/3 )* | *28 (17/5)* | *05/ 0<* 05/ 0<* 05/ 0<* 05/ 0<* |
| | *45-55%* | *126 (76/8)* | *60 (38/7)* | *81 (56/3)* | *10 (47/6 )* | *94 (58/8)* | |
| | *30-45%* | *9 (5/5)* | *48 (31)* | *45 (31/3)* | *4 (19)* | *14 (8/8)* | |
| | *<30%* | *15 (9/1)* | *42 (27/1)* | *8 (5/6)* | *-* | *24 (15)* | |
| *Valvular Heart Disorders* | *MAC (Mitral Annular Calcificatio n)* | *10 (6/1)* | *18 (13/4)* | *5 (3/1)* | *1 (3/3)* | *4 (2/6)* | *05/ 0< 05/ 0< 05/ 0<* |
| | *MVP (Mitral Valve Prolapse)* | *9 (5/5)* | *4 (3)* | *9 (5/6)* | *2 (6/7)* | *21 (13/5)* | |
| | *MS (Mitral Stenosis)* | *3 (1/8)* | *3 (2/2)* | *-* | *-* | *-* | |
| | *AVS (Aortic Valve Stenosis)* | *3 (1/8)* | *2 (1/5)* | *1 (0/6)* | *-* | *-* | |
| *Left Ventricular Hypertrophy (LVH)* | *Mild* | *65 (39/6)* | *48 (35/8)* | *47 (29/2)* | *7 (23/3 )* | *43 (27/7)* | *05/ 0<* 05/ 0<* 05/ 0<* |
| | *Moderate* | *22 (13/4)* | *9 (6/7)* | *18 (11/2)* | *3 (10)* | *13 (8/4)* | |
| | *Severe* | *18 (11)* | *5 (3/7)* | *8 (5)* | *-* | *6 (3/9)* | |
| *Left Ventricular Hypertrophy (LVH)* | *Yes* | *28 (17/1)* | *16 (11/9)* | *8 (5)* | *2 (6/7)* | *6 (3/9)* | *05/ 0<* 05/ 0<* |
| | *No* | *136 (82/9)* | *118 (88/1)* | *153 (95)* | *28 (93/3 )* | *149 (96/1)* | |
| *Regional Wall Motion Abnormality (RWMA)* | *Aneurysm* | *1 (0/6)* | *1 (0/7)* | *1 (0/6)* | *-* | *3 (1/9)* | *05/ 0< 05/ 0< 05/ 0<* |
| | *Hypokines ia* | *4 (2/4)* | *25 (18/7)* | *4 (2/5)* | *-* | *2 (1/3)* | |
| | *No* | *159 (97)* | *108 (80/6)* | *156 (96/9)* | *30 (100)* | *150 (96/8)* | |
| *Patent Foramen Ovale (PFO)* | *Yes* | *1 (0/6)* | *-* | *2 (1/2)* | *-* | *7 (4/5)* | *05/ 0<* |
| | *No* | *163 (99/4)* | *134 (100)* | *159 (98/8)* | *30 (100)* | *148 (95/5)* | |
| *Aortic Plaque* | *Yes* | *5 (3)* | *-* | *3 (1/8)* | *-* | *-* | *05/ 0<* |
| *Mass* | *Bacterial Vegetation* | *-* | *3(2/2)* | *-* | *-* | *-* | *05/ 0<* |
| | *Tumor* | *1(0/6)* | *-* | *-* | *-* | *-* | |

*The results on the frequency of cardiac disorder assessments in ischemic stroke patients, categorized by etiology according to the TOAST classification, are shown in Table (6). The highest frequency of etiological factors, as per the TOAST classification, was observed in large-artery atherosclerosis (LAA) (25.5%) and stroke of undetermined cause (24.8%). This was followed by cardioembolic stroke (24.1%), small-vessel occlusion (22.4%), and stroke due to other identified causes (3.3%).*

*The highest prevalence of cardiac disorders was observed in the large-artery atherosclerosis group. Statistically significant differences (P < 0.05) were noted in the frequency of rhythm abnormalities, ejection fraction, left ventricular hypertrophy, valvular heart disorders, and left atrial enlargement (LAE) among the different etiological groups. However, no statistically significant differences were found in the frequency of*

*regional wall motion abnormalities (RWMA), patent foramen ovale (PFO), aortic plaque, and cardiac masses across the different etiological groups.*

***Discussion***

*The results indicated that hypertension had the highest prevalence among the risk factors (68.8%), followed by diabetes (44.7%), ischemic heart disease (32.1%), smoking (28.7%), a history of previous stroke or TIA (27%), dyslipidemia (15.2%), a history of coronary artery bypass grafting (CABG) (5%), and a history of heart valve surgery (1.4%). Hypertension, diabetes, and smoking were significantly more prevalent in men than in women, while dyslipidemia was more common in women than in men. The high prevalence of hypertension in this study aligns with the findings of Aghdam et al. in Urmia (17), Zafar et al. in Pakistan (18), Habibi-Kolayi et al. in Gorgan (19), and Azarpajouh et al. in Mashhad (20).*

*In the present study, the prevalence of large-artery atherosclerosis (LAA) was 25.5%, and stroke of undetermined origin (SUO) accounted for 24.9%. Following these, cardioembolic stroke was observed in 24.1% of cases, small-vessel occlusion in 22.4%, and stroke due to other identified causes in 3.3%. In a study by Lipska et al., cardioembolic stroke (25.2%) was reported as the most common subtype, followed by large-artery atherosclerosis (12.6%). Additionally, 11.2% of patients had strokes due to other determined causes (21). Similarly, in a study by Khoroush et al. in Isfahan, ischemic stroke of undetermined origin was the most common etiology (43%) among 1,910 patients classified according to the TOAST criteria (22).*

*In this study, transthoracic echocardiography (TTE) was conducted on 644 patients with ischemic stroke. Only 24 patients underwent all three types of echocardiography: TTE, transesophageal echocardiography (TEE), and contrast echocardiography. Additionally, an electrocardiogram (ECG) was recorded for all patients, which revealed that 513 had sinus rhythm and 131 had atrial fibrillation (AF). Among the patients with sinus rhythm, 172 underwent Holter monitoring, with 126 having 24-hour monitoring, 37 with 48-hour monitoring, 6 with 72-hour monitoring, and 3 with 96-hour monitoring. Of those who underwent Holter monitoring, 158 showed sinus rhythm, while 14 patients (8.1%) were diagnosed with AF—9 detected during 24-hour monitoring and 5 during 48-hour monitoring.*

*In the study, the most common cardiac findings among patients with acute ischemic stroke were sinus rhythm, an ejection fraction (EF) between 45–55%, and mild left ventricular hypertrophy (LVH), with a higher prevalence in men. AF was present in 145 patients (22.5%), while the remaining patients had sinus rhythm. Half of the patients had an EF between 45–55%, and approximately one-third exhibited mild LVH.*

*Valvular heart disorders were present in 95 patients, including mitral annular calcification (MAC) in 38 patients, mitral valve prolapse (MVP) in 45 patients, mitral stenosis (MS) in 6 patients, and aortic valve stenosis (AVS) in 6 patients. Left atrial enlargement (LAE) was observed in 60 patients, while regional wall motion abnormalities (RWMA) were found in 41 patients (35 with hypokinesia and 6 with aneurysm). Additionally, 10 patients had a patent foramen ovale (PFO) (8 with a shunt and 2 without), 8 patients had aortic plaques, and 4 patients had cardiac masses (3 with bacterial vegetations and 1 with a tumor).*

*The highest etiologic prevalence of stroke, based on the TOAST classification, was observed in large-artery atherosclerosis (LAA) and stroke of undetermined etiology (SUE). The highest prevalence of cardiac disorders was found among men, the 61–80 age group, patients with large-artery atherosclerosis, and those with hypertension as a risk factor. The differences in heart rhythm, EF, LVH, and LAE between men and women, different age groups, and different stroke etiologies were statistically significant.*

*In a study by Wira et al. in the United States, among 200 patients with acute ischemic stroke with a mean age of 65 years, 57 patients (28.5%) had an EF below 50%, and 18 patients (10.5%) had AF (23). More than half of the patients were women, and hypertension was the most common risk factor, present in 62% of cases (23). In contrast, in the present study, 10% of patients had an EF of ≥55%, while 90% had an EF of <55%, and AF was observed in 22.5% of patients. Women constituted 43% of the patient population, and hypertension was present in approximately 69% of cases. However, the mean age of patients was around 65 years, similar to their study.*

*The present study identified a relatively high percentage of modifiable risk factors for ischemic stroke among patients, with hypertension and diabetes being the most common risk factors. These findings emphasize the need for serious primary and secondary prevention efforts targeting modifiable risk factors (24).*

*The study by Habibi-Kolayi (19) in Gorgan confirmed that age above 70 years is associated with a higher risk of stroke, similar to other studies conducted in the Iranian population. However, their observation that more than half of stroke cases occurred in individuals under the age of 69 (19), along with the fact that all patients in the present study were under this age, suggests a trend of stroke occurring at younger ages in the Iranian population (20).*

*A systematic review of three large studies highlighted a significant increase in the prevalence of hypertension, followed by hypercholesterolemia, and a notable rise in the number of risk factors per ischemic stroke patient over the age of 35. This concerning trend underscores the need to identify stroke risk factors among younger individuals to establish effective preventive strategies and manage these risk factors properly (19).*

*There is considerable debate regarding the use of Holter monitoring in stroke patients. In a study by Liao et al. involving 736 patients with acute ischemic stroke, the detection rate of newly diagnosed AF through Holter monitoring was reported to be 4.6% (15). The low detection rate may be due to unselected patients and variations in the duration and timing of monitoring. A review of various studies suggests that early and prolonged monitoring may improve detection rates.*

*Holter monitoring can also be useful for identifying patients with characteristics associated with occult AF, who may require long-term heart rhythm monitoring. Wallman et al. reported that frequent premature atrial beats (≥70 APBs within 24 hours) indicate an increased risk of developing paroxysmal AF, and in such patients, prolonged heart rhythm monitoring predicts the detection of paroxysmal AF in 26% of cases (25).*

***Conclusion***

*Based on the findings of this study, it can be concluded that a history of hypertension, diabetes, dyslipidemia, smoking, ischemic heart disease, and valvular heart disease were significant risk factors for ischemic stroke among the evaluated patients. The highest prevalence of cardiac disorders was found among men, the 61–80 age group, patients with large artery atherosclerosis, and those with hypertension as a risk factor. These findings can guide healthcare organizations in identifying key priorities and improving the quality of care for ischemic stroke patients, as well as the evaluation of cardiac disorders in hospitals.*

*This study has several limitations, including its single-center design and retrospective nature. It is recommended that future studies be conducted over a longer period with a larger, multi-center sample to achieve higher-quality and more well-documented results. Additionally, a prospective study should be designed in which patients are categorized from the outset and their data systematically recorded for more precise analysis.*

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