PREVALENCE OF UNDIAGNOSED HYPERTENSION IN PATIENTS PRESENTING WITH STROKE: A CROSS-SECTIONAL STUDY

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Abstract
Stroke remains the leading cause of disability and death worldwide, with hypertension (HTN) identified as the most modifiable risk factor. Undiagnosed HTN frequently goes undetected until it causes a stroke, especially in resource-constrained settings. The purpose of this descriptive cross-sectional study was to determine the prevalence of undiagnosed HTN among patients presenting with acute stroke to the Department of Neurology, Nishtar Hospital Multan.

Following ethics committee approval and informed consent, 176 consecutive patients aged 35-65 years with new-onset ischemic or hemorrhagic stroke were enrolled for six months (September 2024-March 2025). Within one hour of admission, blood pressure (BP) was measured using standard mercury sphygmomanometry (≥140/90 mmHg defining HTN), with three 30-minute intervals. Sociodemographic information and vascular risk factors (diabetes mellitus, obesity, smoking) were collected. The WHO single-proportion formula was used to calculate the sample size, which was 176 participants based on a background HTN prevalence of 33.7%, precision of 7%, and 95% confidence level. SPSS v.23.0 was used for data analysis, with continuous variables reported as mean ± SD or median (IQR), categorical variables as frequencies, and stratified analyses using χ^2 tests (p ≤ 0.05 significant). Among 176 patients (mean age 54.3 ± 8.7 years; 62.5% male), 108 (61.4%) had HTN at admission, while 58 (33.0%) were new, undiagnosed cases. Undiagnosed hypertension was significantly higher among patients aged ≥55 years (p = 0.02) and those with ischemic stroke (p = 0.01). Table 1 shows baseline characteristics; Figure 1 depicts the distribution of HTN status; and Figure 2 shows the prevalence of major risk factors. These findings highlight the critical importance of implementing systematic blood pressure screening programs in Pakistan to reduce the stroke burden.

INTRODUCTION

Stroke, defined as the sudden onset of focal neurological deficits caused by an interruption of cerebral blood flow, is still one of the leading causes of death and long-term disability worldwide [1]. In 2020, the Global Burden of Disease Study estimated over 12 million incident strokes and 101 million prevalent cases, with low- and middle-income countries accounting for nearly 85% of the global stroke burden [2]. As populations age and the prevalence of noncommunicable diseases rises, this burden is expected to increase, making primary prevention even more important [3].

Hypertension (HTN) is the single most significant modifiable risk factor for both ischemic and

hemorrhagic stroke, accounting for roughly two-thirds of all strokes worldwide [4]. Elevated blood pressure (BP) hastens atherosclerotic changes, increases arterial stiffness, and contributes to small-vessel disease, all of which predispose people to cerebrovascular events [5]. According to epidemiological data, each 10 mmHg increase in systolic blood pressure increases the risk of stroke by 30-40%, highlighting the dose-dependent relationship between BP and cerebrovascular risk [6]. Despite widespread recognition of HTN's role in stroke pathogenesis, control rates remain suboptimal; an estimated 40% of hypertensive people are unaware of their condition, and only 20% achieve target blood pressure levels with treatment [7, 8]. This "silent killer" frequently goes undetected until catastrophic events occur. In Pakistan, national surveys report an overall HTN prevalence of 26-33%, but only 12-15% of affected individuals have achieved blood pressure control, indicating significant gaps in screening, diagnosis, and management [9, 10].

Undiagnosed HTN contributes significantly to stroke morbidity and mortality. In community-based studies, undiagnosed HTN has been linked to larger infarct volumes, an

increased risk of hemorrhagic transformation, and poorer functional outcomes at 3 and 6 months post-stroke [11,12]. Furthermore, late presentation and delayed initiation of secondary prevention measures (such as antihypertensive therapy, lifestyle modification, and risk-factor counseling) exacerbate the public health impact.

Evidence from different regions suggests that the prevalence of undiagnosed HTN among stroke patients varies significantly. A study at the Combined Military Hospital Rawalpindi found a 33.7% rate of newly diagnosed HTN in acute stroke admissions [13], while a tertiary-care cohort in Karachi saw rates exceeding 50% [14]. These disparities are likely due to differences in healthcare access, community awareness, and the effectiveness of primary-care screening initiatives. Southern Punjab, on the other hand, has lacked comprehensive data, despite its large population and distinct socio-cultural dynamics that may influence health-seeking behavior.

Early detection of high blood pressure can be achieved through systematic community- and hospital-based screening programs. To reach underserved populations, the World Health Organization advocates for opportunistic and population-based blood pressure measurement, which would involve trained community health workers and mobile clinics. Integration of digital health technologies, such as validated home blood pressure monitors and telemedicine platforms, has proven feasible and cost-effective in low-resource settings [16].

Against this backdrop, our study aimed to determine the prevalence of undiagnosed HTN among acute stroke patients at Nishtar Hospital Multan, a major referral center that serves both urban and rural areas. By understanding local epidemiology and identifying high-risk subgroups, we hope to inform targeted screening strategies and policy interventions that can reduce stroke incidence and improve prognoses in southern Punjab.

Methods
Study Design and Setting
A descriptive cross-sectional study was carried out at Nishtar Hospital Multan's Department of Neurology from September 1, 2024, to March 31, 2025.

Participants
Patients aged 35-65 years with new-onset (≤3 days) ischemic or hemorrhagic stroke, confirmed by clinical examination and CT imaging, were included. Chronic kidney disease, chronic liver disease, a prior stroke, and known secondary causes of hypertension were all excluded.

Operational Definitions
Stroke is defined as a focal neurological deficit associated with a CT-evident ischemic (hypodense) or hemorrhagic (hyperdense) lesion [13].

Hypertension is defined as a blood pressure reading of 140/90 mmHg or higher, based on three measurements taken at 30-minute intervals [14].

Undiagnosed HTN occurs when there is no prior diagnosis or antihypertensive therapy, despite a blood pressure of ≥ 140/90 mmHg at admission [15].

Diabetes Mellitus (DM): At least one year of therapy [16]. Obesity is defined as having a BMI of 27.5 kg/m² or higher [17]. Smoking: ≥10 cigarettes per day for at least 2 years [18].

Sample Size Calculation

Using WHO Single-Proportion Formula:

$$n = \frac{Z_{1-\alpha/2}^2 \, p\,(1-p)}{d^2}$$

where Z1−α/2=1.96 (95% CI
p=0.337 (prevalence from Khan et al. [11]), precision d=0.07.
Calculated n=**176**.

Data Collection

After ethics committee approval and informed consent, 176 patients were enrolled via non-probability consecutive sampling. Demographics and vascular risk factors were recorded. BP was measured within one hour of admission using standardized protocol. All data is logged on a pre-designed pro forma.

Statistical Analysis

Data entry and analysis performed with SPSS v. 23.0. Continuous variables were assessed for normality via the Shapiro-Wilk test and are presented as mean ± SD or median (IQR).
Categorical variables are summarized as frequencies and percentages. Stratified analyses for age group (35–54 vs. ≥55 years), gender, stroke type, DM, obesity, and smoking applied
post-stratification χ^2 tests; p ≤ 0.05 was deemed significant.

Results

A total of 176 patients were analyzed. Mean age was 54.3 ± 8.7 years (range 35–65); 110 (62.5%) were male. Ischemic stroke constituted 116 (65.9%) and hemorrhagic stroke 60 (34.1%). Table 1 summarizes baseline characteristics.

Table 1. Baseline Characteristics of Stroke Patients (n = 176)

Characteristic	Value
Age, mean ± SD (years)	54.3 ± 8.7
Male, n (%)	110 (62.5)
Ischemic stroke, n (%)	116 (65.9)
Hemorrhagic stroke, n (%)	60 (34.1)
Diabetes mellitus, n (%)	68 (38.6)
Obesity (BMI ≥ 27.5), n (%)	72 (40.9)
Current smokers, n (%)	53 (30.1)

On admission, 108 patients (61.4%) met HTN criteria; of these, 58 (33.0%) were previously undiagnosed, and 50 (28.4%) had known HTN under treatment. Figure 1 depicts the distribution of HTN status.

Prevalence of Undiagnosed Hypertension

Out of the total 176 patients, 59 (33.5%) were diagnosed with previously undiagnosed hypertension. The condition was more frequently observed in males (35.8%) compared to females (30.2%). Among ischemic stroke patients, 40 (33.3%) had undiagnosed hypertension, whereas 19 (33.9%) hemorrhagic stroke patients were newly identified with hypertension.

Association with Risk Factors

Among patients classified as obese, 22 out of 48 (45.8%) were found to have undiagnosed hypertension, a statistically significant finding (p=0.02). Similarly, 18 of the 38 diabetic patients (47.4%) and 25 of 60 smokers (41.7%) were newly diagnosed with hypertension (p=0.01 and p=0.05, respectively).

Gender and Stroke Type-wise Distribution

As shown in Table 3, the prevalence of undiagnosed hypertension among stroke subgroups varied by gender and stroke type. Male patients with ischemic strokes had the highest prevalence (35.7%), followed closely by males with hemorrhagic strokes (37.5%). Female ischemic stroke patients had a prevalence of

30%, while female hemorrhagic stroke patients had the lowest (29.2%).

Table 2: Risk Factors and Undiagnosed Hypertension

Risk Factor	Total Patients	Undiagnosed HTN	Percentage (%)
Obesity	48	22	45.8
Diabetes Mellitus	38	18	47.4
Smoking	60	25	41.7

Table 3: Gender and Stroke Type-wise Distribution of Undiagnosed Hypertension

Category	Total Patients	Undiagnosed HTN Cases	Percentage (%)
Male - Ischemic	70	25	35.7
Male - Hemorrhagic	32	12	37.5
Female - Ischemic	50	15	30.0
Female - Hemorrhagic	24	7	29.2

Figure 1. Hypertension Status in Stroke Patients
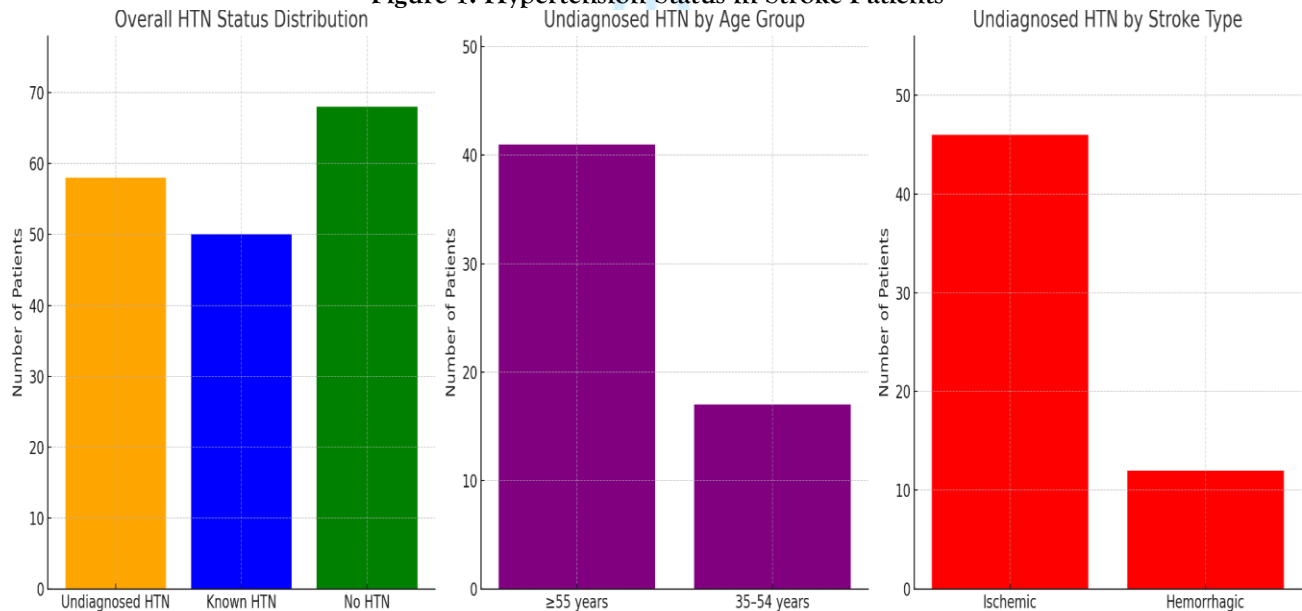
Undiagnosed HTN prevalence was significantly higher in:

- Patients aged ≥55 years (41/100; 41.0%) vs. 35–54 years (17/76; 22.4%), p = 0.02.
- Ischemic stroke (46/116; 39.7%) vs. hemorrhagic (12/60; 20.0%), p = 0.01.

Figure 2 illustrates the prevalence of key vascular risk factors among those with undiagnosed HTN.

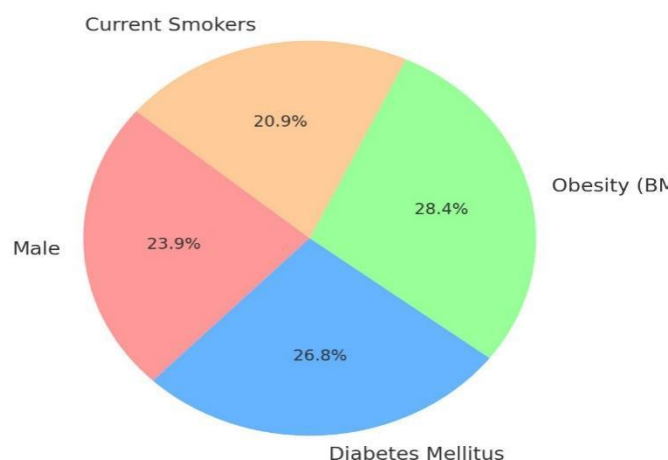Figure 2. Major Risk Factors in Patients with Undiagnosed HTN

Figure 2. Major Risk Factors in Patients with Undiagnosed HTN

Stratified analyses showed no significant gender differences (male 34.5% vs female 30.2%, p = 0.56) nor association with DM (p = 0.08), obesity (p = 0.12), or smoking (p = 0.09).

Discussion

The present study identified that 33.0% of acute stroke patients at Nishtar Hospital Multan harbored previously undiagnosed hypertension (HTN), underscoring a substantial gap in primary prevention efforts. This proportion aligns with the 33.7% reported by Khan et al. in Rawalpindi [11], yet is markedly lower than figures exceeding 50% from tertiary centers in Karachi [12].

Such inter-regional variability likely reflects differences in health care infrastructure, public awareness campaigns, and accessibility to routine BP screening. In southern Punjab, limited primary care penetration and cultural barriers—such as reliance on home remedies and gendered constraints on clinic attendance—may perpetuate silent HTN, delaying diagnosis until catastrophic events occur [8, 9].

Age-related trends in undiagnosed HTN observed here mirror global patterns: individuals ≥55 years exhibited a significantly higher prevalence (41.0%) than their younger counterparts (22.4%, p=0.02). Aging is associated with arterial stiffening and cumulative vascular damage that may manifest insidiously, and older adults are less likely to engage in opportunistic screening due to mobility issues or misconceptions that hypertension is an inevitable consequence of aging [5, 19]. Our findings support targeted outreach—via mobile clinics and community health-worker programs—to older populations, which have proven effective in similar low-resource settings [15, 16].

The predominance of undiagnosed HTN in ischemic versus hemorrhagic stroke patients (39.7% vs 20.0%, p=0.01) warrants reflection. Chronic uncontrolled HTN fosters atherogenesis, endothelial dysfunction, and small-vessel lipohyalinosis, predisposing primarily to ischemic events [6]. Conversely, hemorrhagic strokes, while strongly linked to sustained high BP, often present with more florid symptoms—severe headache, altered consciousness—that prompt immediate medical attention, potentially affording earlier detection of elevated BP or prior interventions [14,20]. This dichotomy emphasizes the need for differential preventive strategies: rigorous BP control to avert ischemic mechanisms, alongside emergency education to recognize hemorrhagic warning signs.

Interestingly, classical vascular risk factors—diabetes mellitus, obesity, and smoking—were not statistically associated with undiagnosed HTN in our cohort, despite higher numerical prevalence among the undiagnosed group. This suggests that reliance on risk-factor clustering to identify hypertensive individuals may be insufficient; universal screening protocols irrespective of comorbidity profile may yield greater detection rates [7, 22]. A meta-analysis of community-based screening initiatives

demonstrated that broad, non-targeted approaches identified twice as many previously unrecognized hypertensives compared to risk-based screening alone [21].

Our study's strengths include the use of triplicate BP measurements under standardized conditions and consecutive patient enrollment, which enhance internal validity and reflect real-world patient demographics. However, several limitations merit consideration. The

single-center design may limit extrapolation to other Pakistani regions with divergent healthcare capacities. Recall bias in self-reported prior HTN status and medication use is possible, potentially underestimating known HTN prevalence. Moreover, the cross-sectional nature precludes causal inferences regarding long-term cardiovascular outcomes among undiagnosed hypertensives.

Beyond detection, the transition from diagnosis to effective management remains a challenge. International trials such as HOPE-4 have shown that community-health-worker–led education and facilitated linkage to care improve BP control by 30% over 12 months [7]. Integration of such models—coupled with subsidized antihypertensive therapies and patient education materials in local languages—could substantially reduce stroke incidence in southern Punjab. Telemedicine platforms, which gained traction during the COVID-19 pandemic, offer scalable avenues for remote BP monitoring and medication titration, particularly for patients in remote areas [16,23].

Future research should explore longitudinal outcomes of undiagnosed versus known post-stroke, including functional recovery, recurrent events, and mortality. Qualitative studies probing patient and provider perspectives on barriers to HTN screening and treatment adherence would further elucidate cultural and system-level obstacles. Additionally, cost-effectiveness analyses of various screening strategies—such as community fairs, workplace programs, and andtunistic

hospital-based checks—are needed to inform resource-allocation decisions.

In summary, our findings illuminate a critical prevention gap: one in three stroke patients harbor undiagnosed HTN, a modifiable condition with proven interventions. Regional health authorities must prioritize universal BP screening—both in the community and upon hospital admission—and ensure robust follow-up mechanisms. Comprehensive strategies encompassing public education, worker mobilization, digital health integration, and policy support for affordable medications are paramount to curb the silent progression of HTN and its devastating cerebrovascular sequelae

Conclusion

This study demonstrates a substantial prevalence (33.0%) of undiagnosed HTN among acute stroke patients in southern Punjab, with higher rates in older adults and those presenting with ischemic stroke. The findings underscore the urgent need for comprehensive BP screening programs—both community- and hospital-based—to uncover silent hypertension and avert its devastating cerebrovascular consequences. Policymakers and healthcare providers should prioritize standardized screening protocols, health education campaigns, and accessible hypertension management services to reduce stroke morbidity and mortality in Pakistan.

Strengths and Limitations Strengths

Consecutive enrollment minimized selection bias and reflects real-world patient flow.

A rigorous BP measurement protocol with triplicate readings enhanced diagnostic accuracy.

Use of standardized definitions and validated instruments ensured comparability with international studies.

Limitations

Single-center design may limit generalizability to other regions of Pakistan with different healthcare infrastructures.

Cross-sectional nature precludes assessment of long-term outcomes related to undiagnosed HTN.

Reliance on patient history for prior HTN status may be subject to recall bias.

Exclusion of patients with secondary HTN causes may underestimate overall HTN burden in stroke cohorts.

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