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Original Article

Perceived Stroke Risk, Blood Pressure Control, and Preventive Health Behaviors Among Adults with Hypertension

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ABSTRACT

Background: Hypertension is a major modifiable risk factor for stroke, yet awareness of cerebrovascular risk does not necessarily translate into effective preventive practices. Objective: To investigate associations between perceived stroke risk, blood pressure control, and preventive health behaviors among adults with hypertension. Methods: This analytical cross-sectional study was conducted over six months at Ittefaq Hospital, Lahore, Pakistan. Convenience sampling was employed, and 58 participants were included in the final cleaned dataset. Two blood pressure readings were recorded, and perceived 10-year stroke risk, risk awareness, medication adherence, physical activity, dietary practices, and healthcare utilization were assessed. Data were analysed using IBM SPSS Statistics version 26.0. Results: The participants' mean age was 52.36 ± 13.29 years, and 32 (55.2%) had uncontrolled blood pressure. Mean perceived 10-year stroke risk was 18.74 ± 12.89%. Participants with uncontrolled blood pressure reported higher perceived stroke risk than those with controlled blood pressure (median 20.0% versus 11.0%; p=0.005). Perceived risk correlated positively with hypertension duration (ρ=0.632; p<0.001), age (ρ=0.577; p<0.001), and systolic blood pressure (ρ=0.421; p=0.001). Among medication users, adherence was poorer in the uncontrolled group (p<0.001). After adjustment for age and hypertension duration, higher perceived stroke risk remained associated with lower odds of blood pressure control (adjusted OR=0.21; 95% CI: 0.08–0.55; p=0.001). Conclusion: Uncontrolled blood pressure was associated with greater perceived stroke risk and poorer medication adherence. Higher perceived risk was not consistently accompanied by more favorable preventive behaviors, indicating a potential gap between risk awareness and hypertension self-management. Keywords: Hypertension; Stroke Risk Perception; Blood Pressure Control; Preventive Health Behaviors; Medication Adherence; Pakistan.

INTRODUCTION

Stroke remains a leading cause of mortality, long-term disability, and healthcare expenditure worldwide. According to the Global Burden of Disease Study 2021, stroke continues to contribute substantially to premature mortality and disability-adjusted life-years, with considerable geographical inequalities in its occurrence and outcomes (1). Elevated systolic blood pressure is among the most important modifiable contributors to the global stroke burden, accounting for a substantial proportion of cerebrovascular morbidity and mortality (2). Contemporary recommendations from the American Heart Association and American Stroke Association emphasize early identification and sustained management of vascular risk factors, particularly hypertension, alongside appropriate lifestyle modification and preventive healthcare (3). The importance of blood pressure reduction is supported by systematic evidence demonstrating that antihypertensive treatment reduces major cardiovascular events, including stroke, across a broad range of patient populations (4).

The burden of hypertension is particularly relevant in Pakistan, where demographic changes, urbanization, dietary transitions, and difficulties maintaining effective long-term treatment contribute to cardiovascular disease risk. Findings from the Second National Diabetes Survey of Pakistan demonstrated a substantial burden of hypertension across urban and rural populations, highlighting the importance of population-level screening and risk-factor management (5). Research conducted in rural central Punjab similarly identified important deficiencies in hypertension awareness, treatment, and control, suggesting that access to healthcare alone may be insufficient to achieve satisfactory blood pressure management (6). Investigations involving Pakistani patients have also documented inadequate therapeutic control and the persistence of modifiable cardiovascular risk factors despite the availability of antihypertensive medication (7). Studies from Karachi have reported associations between hypertension-related

knowledge and blood pressure control, although the relationship between understanding disease complications and maintaining favorable treatment behaviors is not always straightforward (8,9).

Perceived stroke risk represents an individual's subjective assessment of the likelihood of experiencing a cerebrovascular event. This perception may be influenced by personal health experiences, age, family history, knowledge of hypertension, perceived disease severity, and awareness of other vascular risk factors. Importantly, subjective risk perception is not necessarily equivalent to objectively estimated stroke probability. Powers and colleagues investigated perceived and calculated stroke risk among men with hypertension and demonstrated the relevance of examining discrepancies between patients' understanding of stroke risk and their clinical risk profiles (10). A study conducted among hypertensive patients in Indonesia identified substantial deficiencies in awareness of stroke susceptibility, with knowledge and socioeconomic characteristics contributing to differences in risk awareness (11). Similarly, research involving adults with hypertension in rural Malaysia demonstrated that cardiovascular risk perception varied according to treatment status, awareness of hypertension, and blood pressure control (12). Population-based research from China has also emphasized the importance of understanding perceived susceptibility to stroke when designing prevention and health education strategies (13).

The relationship between perceived risk and preventive health behavior is complex. Greater awareness of potential cardiovascular complications may encourage medication adherence, regular blood pressure monitoring, physical activity, dietary modification, and healthcare attendance. Nevertheless, awareness does not necessarily overcome practical, financial, psychological, or behavioral barriers to sustained self-management. A cross-sectional investigation involving 600 hypertensive patients in Iran identified an association between perceived risk of hypertension-related complications and adherence to antihypertensive medication, supporting the potential relevance of patients' beliefs to long-term treatment behavior (14). Qualitative research among patients in Lahore and Sargodha similarly described difficulties translating knowledge of hypertension into consistent treatment and lifestyle practices, including irregular medication use and insufficient follow-up (15). Another Pakistani investigation examining lifestyle modification among hypertensive patients highlighted the need to distinguish awareness of recommended behaviors from their actual implementation (16).

Preventive health behaviors remain fundamental components of comprehensive hypertension management. Regular physical activity contributes to cardiovascular health, with international recommendations emphasizing the importance of reducing inactivity and increasing appropriate weekly exercise (17). Dietary interventions, particularly reduced sodium intake and increased consumption of nutrient-rich foods, can also improve blood pressure regulation. The DASH-Sodium trial demonstrated clinically meaningful blood pressure reductions associated with sodium restriction and a dietary pattern rich in fruits, vegetables, and other beneficial food groups (18). Earlier randomized evidence from the Dietary Approaches to Stop Hypertension trial established that modifying overall dietary patterns can reduce blood pressure independently of pharmacological treatment (19). However, implementation of these recommendations varies according to individual resources, motivation, health literacy, and access to ongoing clinical support.

Recent research has continued to examine behavioral determinants of stroke prevention among patients with uncontrolled hypertension. A Thai cross-sectional study identified factors associated with stroke-prevention behavior, reinforcing the importance of investigating preventive practices alongside individual perceptions of cerebrovascular risk (20). Research examining stroke-related predictors of hypertension self-management has likewise emphasized that perceived susceptibility, disease knowledge, and behavioral determinants may interact in ways that are not adequately represented by awareness measures alone (21). Although these relationships have been investigated internationally, hospital-based evidence from Pakistan examining subjective stroke-risk estimates, objectively recorded blood pressure, and multiple preventive behaviors within the same hypertensive population remains comparatively limited.

Understanding these associations is clinically relevant because patients who recognize their susceptibility to stroke may nevertheless fail to achieve adequate blood pressure control or maintain recommended preventive practices. Identifying discrepancies between risk perception and self-management may help inform more targeted patient education and counseling in routine hypertension care. Therefore, the present study aimed to investigate the association between perceived stroke risk, blood pressure control, and preventive health behaviors among adults with hypertension attending Ittefaq Hospital, Lahore, Pakistan. The study also examined relationships between perceived stroke risk, demographic and clinical characteristics, medication adherence, lifestyle practices, and healthcare utilization.

MATERIALS AND METHODS

An analytical cross-sectional study was conducted over six months at Ittefaq Hospital, Lahore, Pakistan, to examine the relationships between perceived stroke risk, blood pressure control, and preventive health behaviors among adults with hypertension. The study population comprised adults aged 18 years or older with hypertension who were recruited from the hospital using a non-probability convenience sampling technique. A total of 58 participants were included in the final analytical dataset following data cleaning and verification. The sampling approach reflected the availability of eligible individuals during the study period. The analysis was based on a single assessment of each participant, consistent with the observational cross-sectional design.

Data were organized using a structured data-collection proforma covering demographic characteristics, clinical history, blood pressure measurements, perceived stroke risk, and preventive health practices. Demographic variables included age, gender, marital status, educational attainment, employment status, residence, and monthly household income. Clinical characteristics included duration of hypertension, height, weight, diabetes mellitus, cardiovascular disease, family history of stroke, and current antihypertensive medication use. Body mass index was calculated by dividing weight in kilograms by the square of height in meters and was expressed in kg/m^2.

Blood pressure assessment comprised two recorded systolic and diastolic measurements, expressed in millimeters of mercury (mmHg). Mean systolic and diastolic blood pressure values were calculated from the corresponding two readings for each participant. Blood pressure control was classified using a threshold of systolic blood pressure below 140 mmHg and diastolic blood pressure below 90 mmHg. Participants meeting both criteria were categorized as having controlled blood pressure, whereas those meeting or exceeding either threshold were categorized as having uncontrolled blood pressure. This operational classification was considered in the context of internationally recognized hypertension assessment and management recommendations (22,23).

Perceived stroke risk was assessed through a subjective estimate of the probability of experiencing a stroke within the following 10 years, recorded as a percentage ranging from 0% to 100%. This measurement represented participants' perceived probability rather than a calculated clinical prediction score. Relative stroke risk perception was recorded by asking participants whether they considered their risk lower than, similar to, or higher than that of people of the same age. Stroke-related worry and perceived seriousness of stroke were assessed using separate five-point response scales, with higher scores indicating greater concern or perceived severity. Knowledge of the relationship between uncontrolled hypertension and stroke was recorded as a binary variable. These risk-perception measures were analysed as individual items rather than combined into an unvalidated composite scale, consistent with the distinction between subjective susceptibility and clinical risk estimation described in previous research (10,13,14).

Preventive health behaviors were assessed through reported frequency of blood pressure monitoring per month, weekly physical activity in minutes, daily fruit and vegetable consumption, use of additional salt during meals, smoking status, and routine clinical follow-up during the preceding six months. Smoking was categorized as never, former, or current smoking, whereas additional salt use was classified as never, sometimes, or usually. These variables represented separate behavioral domains relevant to hypertension management and cardiovascular prevention, including dietary patterns and physical activity described in established preventive health recommendations (17–19).

Medication-related behaviors were evaluated according to current antihypertensive treatment status. Participants taking prescribed antihypertensive medication were assessed for the absolute number of scheduled doses missed during the preceding seven days and the number of days on which medication was taken as prescribed during the same period. These measurements were analysed separately because the number of missed doses does not necessarily correspond to the number of days without medication, particularly when prescribed dosing frequency varies. Medication-adherence analyses were restricted to participants reporting current antihypertensive treatment. For participants not taking antihypertensive medication, adherence-specific measurements were treated as inapplicable rather than interpreted as evidence of medication nonadherence.

The dataset was examined for missing observations, duplicate records, coding inconsistencies, and agreement between recorded and derived measurements. Body mass index and mean blood pressure values were checked against the underlying measurements, and the existing blood pressure control classifications were verified against the operational threshold. Descriptive statistics were calculated for demographic, clinical, perceptual, and behavioral variables. Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, according to their distributional characteristics and analytical purpose. Categorical variables were expressed as frequencies and percentages.

Data were analysed using IBM SPSS Statistics version 26.0. Differences in continuous and ordinal variables between participants with controlled and uncontrolled blood pressure were examined using the Mann–Whitney U test where appropriate. Associations between categorical variables were examined using Pearson's chi-square test or Fisher's exact test for applicable two-by-two comparisons, particularly when expected cell frequencies were small. Spearman's rank correlation coefficient was used to evaluate associations between perceived 10-year stroke risk and demographic, clinical, and preventive behavioral variables.

Exploratory multivariable analyses were performed to examine whether the association between perceived stroke risk and blood pressure control persisted after accounting for age and duration of hypertension. Linear regression with heteroskedasticity-consistent HC3 standard errors was used to estimate differences in perceived stroke risk according to blood pressure control status. Binary logistic regression was used to estimate the association between perceived stroke risk and the odds of controlled blood pressure, with perceived risk expressed per 10-percentage-point increment. Adjusted regression coefficients, odds ratios, 95% confidence intervals, and corresponding p-values were reported. The Benjamini–Hochberg false-discovery-rate procedure was additionally applied to the family of primary blood pressure group comparisons to examine the robustness of findings across multiple comparisons. Statistical significance was assessed at $p<0.05$. The manuscript was organized with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for cross-sectional research (24).

Ethical approval for the study was obtained from Ittefaq Hospital, Lahore, Pakistan. Participant-level information was analysed using anonymized numerical identifiers, and the findings were reported in aggregate form.

RESULTS

A total of 58 adults with hypertension were included in the final analysis. The mean age was 52.36 ± 13.29 years, ranging from 32 to 75 years. The sample comprised 28 males (48.3%), 26 females (44.8%), and four participants (6.9%) recorded under the other/self-described gender category. Twenty-nine participants (50.0%) were married, 27 (46.6%) were employed, and 25 (43.1%) resided in urban areas. The mean body mass index was 28.56 ± 4.09 kg/m^2, while the mean duration of hypertension was 6.16 ± 5.03 years. Diabetes mellitus and cardiovascular disease were each reported by 21 participants (36.2%), and 31 (53.4%) reported a family history of stroke. Antihypertensive medication was being taken by 52 participants (89.7%).

The mean systolic and diastolic blood pressures were 142.57 ± 15.39 mmHg and 88.36 ± 8.54 mmHg, respectively. Based on the study-defined blood pressure threshold, 26 participants (44.8%) had controlled blood pressure, whereas 32 (55.2%) had uncontrolled blood pressure. Age, duration of hypertension, and body mass index did not differ significantly between these groups. A family history of stroke was more frequent among participants with uncontrolled blood pressure than among those with controlled blood pressure (68.8% versus 34.6%; p=0.017). Participants with a family history of stroke had lower odds of controlled blood pressure (unadjusted OR=0.24; 95% CI: 0.08–0.72).

Table 1. Demographic and Clinical Characteristics According to Blood Pressure Control (N=58)

Variable	Total (N=58)	Controlled (n=26)	Uncontrolled (n=32)	p-value
Age (years)	52.36 ± 13.29	53.92 ± 13.69	51.09 ± 13.03	0.439
BMI (kg/m^2)	28.56 ± 4.09	28.30 ± 4.57	28.77 ± 3.71	0.448
Hypertension duration (years)	6.16 ± 5.03	6.35 ± 4.53	6.00 ± 5.46	0.529
Male	28 (48.3)	13 (50.0)	15 (46.9)	—
Female	26 (44.8)	9 (34.6)	17 (53.1)	—
Other/self-described gender	4 (6.9)	4 (15.4)	0 (0.0)	—
Urban residence	25 (43.1)	11 (42.3)	14 (43.8)	1.000
Diabetes mellitus	21 (36.2)	8 (30.8)	13 (40.6)	0.584
Cardiovascular disease	21 (36.2)	7 (26.9)	14 (43.8)	0.272
Family history of stroke	31 (53.4)	9 (34.6)	22 (68.8)	0.017
Antihypertensive medication use	52 (89.7)	25 (96.2)	27 (84.4)	0.209
Awareness of BP–stroke relationship	42 (72.4)	19 (73.1)	23 (71.9)	1.000
Mean systolic BP (mmHg)	142.57 ± 15.39	128.62 ± 4.34	153.91 ± 11.14	—
Mean diastolic BP (mmHg)	88.36 ± 8.54	80.31 ± 2.92	94.91 ± 5.35	—

Values are mean ± standard deviation or n (%). Continuous-variable comparisons used the Mann–Whitney U test; binary categorical comparisons used Fisher's exact test. BP = blood pressure; BMI = body mass index. Blood pressure measurements defined the comparison groups and were therefore not independently tested.

The mean subjective 10-year stroke-risk estimate was 18.74 ± 12.89%, with a median of 15.5% (interquartile range [IQR]: 10.0–24.75%). Participants with uncontrolled blood pressure perceived significantly greater stroke risk than those with controlled blood pressure (median 20.0%, IQR 13.0–27.75%, versus 11.0%, IQR 8.0–19.5%; p=0.005). The corresponding

mean perceived probabilities were 22.50 ± 14.22% and 14.12 ± 9.36%, respectively, representing an unadjusted mean difference of 8.38 percentage points.

Perceived seriousness of stroke was generally high, with an overall mean of 4.29 ± 0.68 on the five-point scale. However, the degree of stroke-related worry and perceived severity did not differ significantly according to blood pressure control status. Similarly, there were no statistically significant differences in routine blood pressure monitoring, fruit consumption, vegetable consumption, or clinic follow-up frequency.

Reported weekly physical activity was greater among participants with controlled blood pressure, although the difference did not reach statistical significance in the rank-based comparison (median 60 versus 45 minutes/week; p=0.085). Medication adherence demonstrated substantially greater differences. Among the 52 participants taking antihypertensive treatment, those with controlled blood pressure reported taking their medication as prescribed on a median of six days per week, compared with five days among those with uncontrolled blood pressure (p<0.001). The median number of missed doses was correspondingly lower in the controlled group (one versus two doses; p<0.001). These associations remained statistically significant after correction for multiple comparisons.

Table 2. Perceived Stroke Risk and Preventive Health Behaviors According to Blood Pressure Control

Variable	Controlled (n=26)	Uncontrolled (n=32)	p-value
Perceived 10-year stroke risk (%)	11.0 (8.0–19.5)	20.0 (13.0–27.75)	0.005
Stroke-related worry (1–5)	3.0 (2.0–4.0)	3.5 (3.0–4.0)	0.879
Perceived stroke severity (1–5)	4.0 (4.0–5.0)	4.0 (4.0–5.0)	0.565
BP checks/month	3.0 (2.0–4.0)	3.5 (1.75–4.5)	0.943
Physical activity (min/week)	60 (30–142.5)	45 (15–90)	0.085
Fruit intake (servings/day)	1.5 (1.0–1.88)	1.0 (1.0–1.5)	0.226
Vegetable intake (servings/day)	1.25 (1.0–2.0)	1.0 (1.0–1.5)	0.237
Clinic visits in previous six months	2.0 (2.0–3.0)	2.0 (2.0–3.0)	0.677
Missed medication doses in seven days*	1.0 (0.0–1.0)	2.0 (1.5–3.0)	<0.001
Days medication taken as prescribed*	6.0 (6.0–7.0)	5.0 (4.0–5.5)	<0.001

Values are median (IQR). P-values are from two-sided Mann–Whitney U tests. *Medication comparisons included 25 participants with controlled BP and 27 with uncontrolled BP. Perceived risk and both medication-adherence comparisons remained significant after Benjamini–Hochberg correction (q=0.015, <0.001, and <0.001, respectively).

Assessment of perceived stroke risk relative to individuals of the same age revealed that 28 participants (48.3%) considered their risk lower, 25 (43.1%) considered it similar, and five (8.6%) considered it higher. The mean estimated 10-year stroke probabilities across these categories were 10.68%, 22.32%, and 46.00%, respectively. All five participants who considered themselves at higher risk than their peers had uncontrolled blood pressure. This subgroup was small and was interpreted descriptively.

Spearman correlation analysis demonstrated positive associations between perceived 10-year stroke risk and hypertension duration (ρ=0.632; p<0.001), age (ρ=0.577; p<0.001), and mean systolic blood pressure (ρ=0.421; p=0.001). The association with diastolic blood pressure was weaker and did not reach statistical significance. Stroke-related worry demonstrated a modest positive correlation with perceived risk (ρ=0.282; p=0.032).

Among preventive behaviors, more frequent blood pressure monitoring and greater physical activity did not demonstrate significant correlations with perceived stroke risk. Fruit intake showed a weak inverse correlation with risk perception (ρ=−0.262; p=0.047), whereas vegetable consumption and clinic attendance showed no significant associations. Among participants receiving antihypertensive medication, greater perceived risk was associated with more missed medication doses (ρ=0.348; p=0.011) and fewer days of medication use as prescribed (ρ=−0.326; p=0.018). These behavioral correlations were exploratory.

Table 3. Spearman Correlations Between Perceived 10-Year Stroke Risk and Clinical or Behavioral Variables

Variable	n	Spearman's ρ	p-value
Age (years)	58	0.577	<0.001
Hypertension duration (years)	58	0.632	<0.001
Mean systolic BP (mmHg)	58	0.421	0.001
Mean diastolic BP (mmHg)	58	0.229	0.084
Stroke-related worry	58	0.282	0.032
Perceived stroke severity	58	0.250	0.059
BP monitoring frequency	58	−0.001	0.992
Physical activity (min/week)	58	−0.169	0.205
Fruit intake (servings/day)	58	−0.262	0.047
Vegetable intake (servings/day)	58	0.014	0.918
Added salt use	58	0.232	0.079
Clinic visits in previous six months	58	−0.068	0.612

Missed medication doses*	52	0.348	0.011
Days medication taken as prescribed*	52	−0.326	0.018

Unadjusted, two-sided Spearman correlations. Added salt use was coded as never, sometimes, or usually. *Medication variables were analyzed only among participants receiving antihypertensive therapy. P-values are unadjusted.

Multivariable linear regression demonstrated that blood pressure control remained independently associated with subjective stroke-risk estimates after adjustment for age and duration of hypertension. Participants with controlled blood pressure had an adjusted perceived-risk estimate 8.78 percentage points lower than participants with uncontrolled blood pressure (B=−8.78; 95% CI: −13.16 to −4.41; p<0.001). Longer hypertension duration was also associated with greater perceived risk (B=2.10 percentage points per year; 95% CI: 0.69–3.51; p=0.004). Age did not demonstrate an independent association within this model. The model explained approximately 62.7% of the observed variation in perceived stroke-risk estimates.

In the corresponding logistic regression model, perceived stroke risk remained associated with blood pressure control after adjustment for age and hypertension duration. Each 10-percentage-point increase in perceived risk was associated with lower odds of controlled blood pressure (adjusted OR=0.21; 95% CI: 0.08–0.55; p=0.001). Neither age nor hypertension duration demonstrated a statistically significant independent association with blood pressure control in this model.

Table 4A. Multiple Linear Regression: Perceived 10-Year Stroke Risk (%) as Outcome

Predictor	B	95% CI	p-value
Controlled BP versus uncontrolled	−8.78	−13.16 to −4.41	<0.001
Age (years)	−0.12	−0.46 to 0.23	0.511
Hypertension duration (years)	2.10	0.69 to 3.51	0.004

N=58; B = unstandardized regression coefficient; HC3 robust standard errors; model R^2=0.627.

Table 4B. Binary Logistic Regression: Controlled BP as Outcome

Predictor	Adjusted OR	95% CI	p-value
Perceived risk (+10 percentage points)	0.21	0.08–0.55	0.001
Age (years)	1.03	0.94–1.13	0.519
Hypertension duration (years)	1.23	0.88–1.72	0.216

N=58; adjusted OR = adjusted odds ratio; CI = confidence interval. Controlled BP coded 1 and uncontrolled BP coded 0. Models include age and hypertension duration.

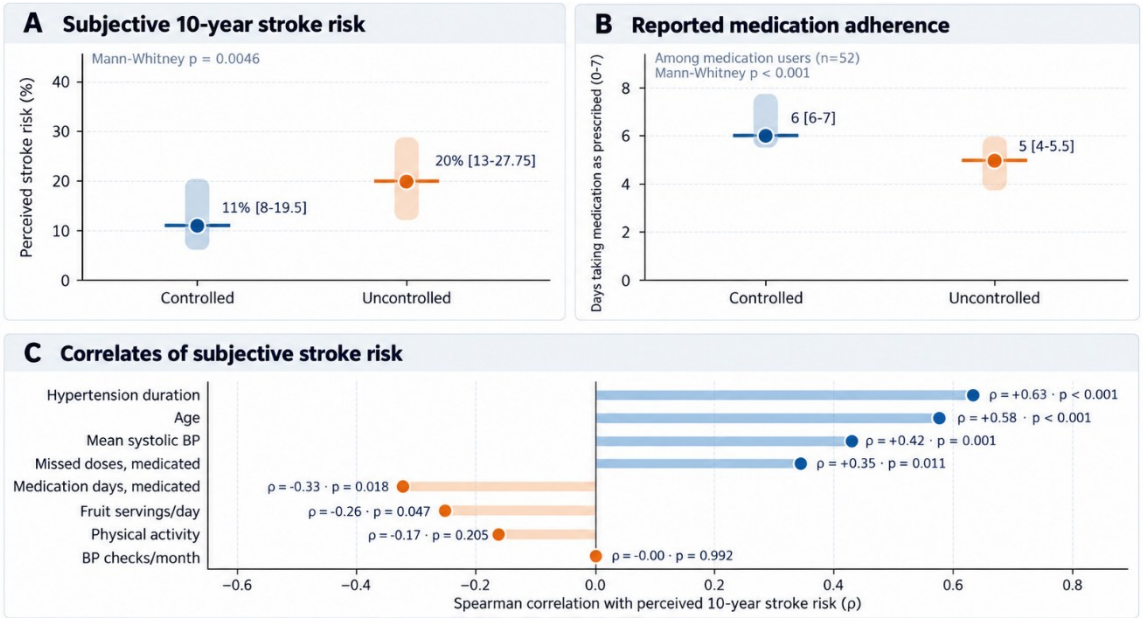


Figure 1. Associations Among Perceived Stroke Risk, Blood Pressure Control, and Medication Adherence Panel A presents perceived risk by BP control status. Panel B summarizes adherence among treated participants (n=52). Panel C displays selected clinical and behavioral Spearman correlations.

The figure demonstrates the higher subjective stroke-risk estimates among participants with uncontrolled blood pressure and the corresponding reduction in reported medication adherence. Hypertension duration demonstrated the strongest correlation with perceived stroke risk (ρ=0.632), followed by age (ρ=0.577) and systolic blood pressure (ρ=0.421). In contrast, correlations involving routine blood pressure monitoring and physical activity were weak, illustrating the limited consistency between perceived risk and preventive practices.

DISCUSSION

The present study investigated the association between perceived stroke risk, blood pressure control, and preventive health behaviors among adults with hypertension attending Ittefaq Hospital, Lahore, Pakistan. Three principal findings emerged. First, more than half of the participants had uncontrolled blood pressure, despite a substantial proportion reporting awareness of the relationship between hypertension and stroke. Second, individuals with uncontrolled blood pressure perceived a greater probability of experiencing stroke, with risk estimates associated with hypertension duration, age, and systolic blood pressure. Third, higher perceived stroke risk did not consistently correspond to more favorable preventive behaviors, whereas medication adherence demonstrated a strong association with blood pressure control. Together, these observations suggest that subjective recognition of cerebrovascular risk and the sustained implementation of preventive behaviors represent related but distinct dimensions of hypertension self-management.

The proportion of participants with uncontrolled blood pressure emphasizes the continuing challenge of effective hypertension management in hospital-based populations. Previous investigations from Pakistan have identified considerable gaps in hypertension detection, treatment, and therapeutic control. Basit and colleagues documented the substantial national burden of hypertension, while Shafi and Shafi demonstrated deficiencies in awareness and control among rural populations in Punjab (5,6). Saleheen and colleagues also reported difficulties achieving satisfactory therapeutic control among Pakistani patients with hypertension (7). Although the present study was smaller and confined to a single hospital, the persistence of uncontrolled blood pressure in a majority of participants is consistent with the broader problem of inadequate hypertension management in Pakistan. The clinical importance of this finding is reinforced by evidence that effective blood pressure reduction substantially decreases stroke and cardiovascular risk (3,4).

The positive association between perceived stroke risk and uncontrolled blood pressure represents an important finding. Participants with uncontrolled hypertension estimated their future probability of stroke to be substantially greater than those whose blood pressure was controlled. This association remained significant after accounting for age and hypertension duration, suggesting that current blood pressure status was related to perceived susceptibility independently of these measured characteristics. However, because exposure and outcome measurements were collected simultaneously, the direction of this relationship cannot be established. Participants may have recognized their elevated risk because of previous clinical advice or awareness of poor blood pressure control, while individuals who perceived themselves at risk may also have differed in other unmeasured clinical or behavioral characteristics.

Previous literature has demonstrated considerable variability in how individuals with hypertension perceive their cerebrovascular and cardiovascular risk. Powers and colleagues examined the relationship between perceived and estimated stroke risk in hypertensive men and highlighted discrepancies between subjective judgments and objectively calculated risk (10). In the present study, perceived 10-year stroke probability was assessed without a corresponding validated clinical stroke-risk calculation. Consequently, the numerical estimates describe subjective susceptibility and cannot establish whether participants accurately estimated their actual probability of stroke. This distinction is clinically important because high perceived risk does not necessarily imply accurate risk appraisal, just as low perceived risk does not necessarily indicate a favorable vascular risk profile.

The findings also provide an interesting comparison with the Malaysian study by Azahar and colleagues, in which individuals with uncontrolled hypertension demonstrated lower cardiovascular risk-perception scores than those with controlled blood pressure (12). The direction of that association differed from the present findings. This discrepancy may reflect differences in the populations studied, treatment experiences, health literacy, risk communication, and measurement instruments. The Malaysian investigation used a multidimensional cardiovascular risk-perception score, whereas the present study obtained a single subjective estimate of 10-year stroke probability. These measures are not directly interchangeable. Similarly, Setyopranoto and colleagues identified low awareness of stroke susceptibility among many Indonesian patients with hypertension, emphasizing that risk perception is shaped by knowledge and contextual factors (11). The differences between these studies illustrate the need to distinguish perceived probability, awareness of susceptibility, emotional concern, and perceived disease severity when interpreting stroke-risk perception.

Age and duration of hypertension demonstrated positive correlations with perceived stroke risk. The association with hypertension duration was particularly pronounced, suggesting that individuals with longer exposure to the condition tended to estimate a higher probability of stroke. One plausible explanation is that prolonged disease experience may increase familiarity with hypertension-related complications, treatment requirements, and medical counseling. Older

adults may also have greater exposure to cardiovascular illness among relatives or peers, potentially influencing their understanding of stroke susceptibility. These possibilities are compatible with previous investigations identifying clinical experience, hypertension knowledge, and personal history as contributors to perceived vascular risk (10–13). Nevertheless, the attenuation of the age association in the adjusted linear model indicates that these characteristics may share explanatory information, and the present analysis cannot establish their independent psychological mechanisms.

A particularly important observation was the limited relationship between subjective stroke-risk perception and several preventive behaviors. Although higher perceived risk might be expected to motivate increased blood pressure monitoring, physical activity, improved dietary habits, and regular clinical review, these behaviors did not consistently demonstrate significant correlations with perceived susceptibility. Routine blood pressure monitoring was almost entirely unrelated to the subjective probability estimate. This finding suggests that recognition of potential stroke risk may be insufficient to establish sustained self-management routines. Behavioral implementation may also depend on health literacy, confidence, perceived control, financial resources, treatment burden, social support, and access to healthcare. Previous research on hypertension-related beliefs and medication adherence has similarly emphasized that perceived risk is only one component of the wider behavioral context influencing chronic disease management (14).

The finding that awareness of the blood pressure–stroke relationship was common but not associated with blood pressure control deserves particular attention. Approximately 72% of participants recognized that uncontrolled hypertension increases the risk of stroke, yet knowledge of this relationship did not distinguish participants with controlled and uncontrolled blood pressure. Earlier research from Karachi found that better hypertension-related knowledge was associated with more favorable blood pressure control (8), while another Pakistani hospital-based investigation examined important deficiencies in hypertension-related knowledge and management (9). The apparent discrepancy may partly reflect differences in how knowledge was assessed. The present study used a single binary item addressing awareness of the relationship between blood pressure and stroke, whereas broader knowledge assessments can capture understanding of treatment, monitoring, complications, and lifestyle recommendations. Recognizing one risk relationship may therefore be less informative than demonstrating comprehensive knowledge of hypertension self-management.

Medication adherence showed the most consistent association with blood pressure control among the preventive behaviors examined. Participants with controlled blood pressure reported fewer missed doses and more days of taking antihypertensive medication as prescribed. This finding is consistent with previous evidence identifying medication nonadherence as an important contributor to inadequate blood pressure control. Durand and colleagues demonstrated the clinical relevance of medication adherence in a systematic review and meta-analysis involving patients with apparent treatment-resistant hypertension (25). Shiraly and colleagues found that perceived risk of hypertension-related complications was associated with medication adherence in an Iranian primary-care population (14). The present findings add a potentially important observation: despite recognizing greater stroke susceptibility, participants with uncontrolled blood pressure also reported poorer medication adherence. This suggests that awareness and adherence may not move in the same direction within every patient population.

The relationship between perceived risk and poorer reported adherence should be interpreted carefully. Individuals experiencing difficulty following treatment may become more concerned about future complications, or repeated uncontrolled blood pressure readings may increase their subjective perception of risk. Conversely, elevated concern could coexist with barriers that prevent adequate treatment, such as complex prescriptions, medication costs, adverse effects, limited social support, or inconsistent healthcare access. These possible explanations were not directly investigated in the present study. A systematic review by De Simoni and colleagues examining adherence-focused interventions after stroke or transient ischemic attack highlighted the complexity of improving blood pressure through medication-related behavioral strategies (26). Morris and colleagues similarly investigated associations between drug adherence and blood pressure control, emphasizing the importance of evaluating adherence and clinical outcomes together rather than treating them as interchangeable indicators (27).

Physical activity demonstrated a directionally favorable pattern, with participants who had controlled blood pressure reporting greater weekly activity. However, the rank-based group comparison did not reach statistical significance. Given the small sample and considerable variation in reported activity, the absence of statistical significance should not be interpreted as evidence that physical activity is clinically unimportant. International recommendations continue to identify regular physical activity as a central component of cardiovascular prevention (17). The 2024 primary stroke-prevention guideline also emphasizes reducing sedentary behavior and promoting appropriate physical activity across

the lifespan (3). The present findings therefore support the relevance of assessing actual activity patterns, including intensity, consistency, and barriers to participation, rather than relying exclusively on awareness of the benefits of exercise.

Dietary behaviors showed similarly limited associations with perceived risk and blood pressure control. Fruit and vegetable intake tended to be greater in the controlled group, but these differences were not statistically significant. Fruit consumption demonstrated a weak inverse correlation with perceived stroke risk in the unadjusted analysis; however, the association was not robust to correction for multiple behavioral comparisons. Such findings should therefore be interpreted as exploratory. The established benefits of dietary modification remain supported by controlled trials, including the DASH and DASH-Sodium investigations, which demonstrated the blood pressure effects of dietary composition and reduced sodium intake (18,19). In the present study, diet was assessed using brief self-reported indicators rather than detailed dietary records, sodium quantification, or a validated dietary adherence score. The resulting measurements may not adequately reflect the complexity of dietary practices relevant to hypertension management.

Family history of stroke was more frequent among participants with uncontrolled blood pressure and was associated with lower unadjusted odds of blood pressure control. This finding may indicate a clustering of familial, genetic, environmental, or behavioral influences on vascular risk. However, the study did not assess genetic susceptibility, shared household dietary practices, or family-level patterns of healthcare utilization. Family history should consequently be interpreted as a recorded clinical characteristic associated with blood pressure status rather than a demonstrated causal determinant. Contemporary stroke-prevention guidance supports individualized assessment of vascular risk in conjunction with comprehensive management of modifiable risk factors (3).

The clinical implications of these findings extend beyond the identification of patients who understand that hypertension increases their risk of stroke. Risk communication may be more useful when accompanied by assessment of actual treatment behaviors, including medication-taking practices, blood pressure monitoring, physical activity, and dietary habits. Qualitative evidence from Pakistan has described difficulties with consistent antihypertensive medication use and sustained lifestyle modification despite awareness of the condition (15). Similar concerns have been identified in research examining adherence to lifestyle recommendations among Pakistani hypertensive patients (16). Studies of stroke-prevention behaviors in other populations have also emphasized that knowledge, perceived susceptibility, and behavioral determinants require coordinated assessment (20,21). In routine hospital care, a patient's stated concern about stroke should therefore not be interpreted as sufficient evidence of effective preventive self-management.

Several strengths of the present investigation merit consideration. The study examined multiple dimensions of hypertension management within the same participant population, allowing relationships among objectively recorded blood pressure, subjective stroke-risk estimates, and self-reported preventive behaviors to be evaluated together. The availability of two blood pressure readings permitted verification of the mean values used for control classification. Separating the absolute number of missed medication doses from the number of days medication was taken as prescribed also avoided treating two related but distinct adherence measures as equivalent. Furthermore, the analyses included effect estimates and confidence intervals, rather than relying exclusively on statistical significance.

The findings must nevertheless be interpreted in the context of important limitations. The cross-sectional design prevents conclusions about temporal or causal relationships, and the hospital-based convenience sample limits external validity. The final analytical sample of 58 participants was relatively small, reducing precision for some comparisons and limiting the number of variables that could reasonably be included in multivariable models. Subjective stroke probability was measured using a single item rather than a validated multidimensional instrument, and no objective stroke-risk calculation was available for comparison. Physical activity, dietary intake, medication adherence, and healthcare utilization were self-reported and may therefore have been affected by recall error or social desirability bias. Residual confounding from medication regimen complexity, healthcare access, socioeconomic circumstances, health literacy, treatment intensity, and other unmeasured factors cannot be excluded. The absence of information on physical activity intensity and detailed dietary composition further restricts interpretation of lifestyle behaviors. Finally, multiple exploratory statistical comparisons increase the possibility of chance findings, despite the application of false-discovery-rate correction to the primary group comparisons.

Taken together, the findings illustrate a clinically relevant distinction between perceived susceptibility to stroke and the practical behaviors required for hypertension management. The observation that participants with uncontrolled

blood pressure perceived greater stroke risk but reported poorer medication adherence suggests that subjective awareness should not be considered an adequate substitute for behavioral assessment. Larger, multicenter studies using validated risk-perception instruments, objectively assessed adherence where feasible, and longitudinal follow-up would help clarify how perceived susceptibility interacts with health literacy, treatment barriers, and subsequent blood pressure control.

CONCLUSION

Among adults with hypertension attending Ittefaq Hospital, Lahore, uncontrolled blood pressure was associated with greater perceived stroke risk and poorer reported medication adherence. Perceived risk increased with hypertension duration, age, and systolic blood pressure but was not consistently associated with more favorable dietary practices, physical activity, blood pressure monitoring, or healthcare attendance. These findings indicate that awareness of cerebrovascular risk and effective hypertension self-management are not necessarily concordant. Assessment of perceived stroke susceptibility should therefore be considered alongside evaluation of medication adherence and preventive health behaviors when identifying patients who may require additional support with blood pressure management.

DECLARATIONS

Authors' Contributions:	Concept: FS; Design: SMBG; Data Collection: FS, UERJ; Analysis: SMBG; Drafting: FS, SMBG, UERJ.
Ethical Approval:	The institution responsible for ethical review was Al Shifa Institute of Health Sciences, Narowal, Pakistan
Informed Consent:	Written informed consent was obtained from all participants before enrolment.
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Data Availability:	De-identified data may be available from the corresponding author on request, subject to participant consent and institutional confidentiality requirements.
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AI Declaration:	Generative AI tools were used solely for language and grammatical refinement. The authors verified the final manuscript and remain fully responsible for its accuracy, integrity, and scientific content.

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