Original Article

Patient Activation As A Predictor Of Medication Adherence In Stroke Patients with Hypertension

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Abstract

Objective: Stroke is one of the main causes of disability and death worldwide. Proper compliance with medications is very important; however, the impact of patient activation has not been studied thoroughly in stroke populations, especially in low-resource settings such as Pakistan. This study aimed to determine whether patient activation is a predictor of medication adherence in hypertensive stroke patients.

Methods: A cross-sectional study of 209 stroke patients with hypertension was conducted at a tertiary care hospital in Pakistan. Medication adherence was evaluated using the Hill-Bone Medication Adherence Scale, and patient activation was measured using the Patient Activation Measure (PAM-13). Sociodemographic data were gathered, as well as reliability testing, ANOVA, Pearson correlation, and multiple linear regression, which were included in the analysis.

Results: The participants showed moderate to high medication adherence (mean (SD) Hill-Bone score: 14.82 (5.90), while patient activation was indicated by a bimodal pattern, with clustering at Level 1 (33.5%) and Level 4 (33.0%), and the median activation level was Level 3 (IQR: 1-4). A substantial association between patient activation and medication adherence was not detected ($r = 0.0004$, $p = 0.99$). Further analysis through regression showed no predictive relationship ($\beta = -0.007$, $p = 0.92$). Additionally, demographic factors did not play a significant role in either construct.

Conclusion: Patient activation was not a predictor of medication compliance. Family and social support may be more dominant than individual activation in maintaining adherence to exercise.

Keywords: Adherence; activation; hypertension; medication; patient; stroke.

Introduction

The Global Burden of Disease (GBD) provides estimates of disability and mortality due to stroke. In 2016, 5.5 million deaths occurred due to stroke globally, and in 2019, it was the second leading cause of disability worldwide in the older age group.[1] From 1990 to 2019, there was a significant rise in stroke cases, with a 70% increase in incident strokes and a 102% increase in prevalent strokes.[2] According to the World Health Organization WHO), approximately 9.7% of deaths occur due to stroke caused by different modifiable factors.[3]

Stroke is preventable if its modifiable risk factors are monitored and controlled. The five major risk factors are hypertension (55%), high body mass index (BMI) (24.3%), high glucose level (20.2%), smoking (17%), and other metabolic risks[2]. As the percentage shows, hypertension is the major contributor to cerebrovascular accidents that require crucial management to avoid recurrence, disability, and mortality. The ratio is higher, likely due to poor blood pressure control and medication noncompliance. The American guidelines for hypertension management recommend that the lower limit of blood pressure be lowered from 140/90 mmHg to 130/80 mmHg, but this could increase the risk of damage.[4]

It is important to study how patients' adherence to medication affects the outcome of stroke. Medication adherence refers to how regularly and consistently patients take the required medications. According to studies, non-adherence in stroke patients varies between 10% and 80%. Some of the factors that could interfere with compliance are multiple doses, false beliefs, unwanted side effects, economic status, and lack of facilities.[5] Previous meta-analyses have shown that hypertensive patients who have shown strict compliance with medications are associated with a reduced risk of stroke and related disability.[6] The Prevention Regimen for Effectively Avoiding Second Strokes (PROFESS) study reported that hypertensive individuals are associated with a higher recurrence of cerebrovascular accidents than non-hypertensive people.[7] Along with medication adherence, patient activation plays a central role, defined as one's confidence and ability to manage their health, which is equally critical, as effective self-management enhances clinical outcomes and quality of life.[8] Dietary modification, exercise, and regular checkups can have a significant impact.[9]

According to research, stroke patients were on a combination of medicines to control different factors, such as hypertension, diabetes, and hyperlipidaemia, which made patient activation difficult. Patients with a chronic history of diseases have shown lower levels of adherence to pharmacological interventions and lower interest in lifestyle modifications to maintain health. Patient activation alone can significantly enhance medication adherence. [10]

In Pakistan, very few studies have been conducted on stroke and its correlation with hypertension and patient activation as predictors, resulting in a significant research gap. Some work has been done regarding the association between chronic disease and stroke, but the effect of patient activation on medication adherence is unclear. This study aimed to assess how patient activation acts as a predictor of medication adherence in stroke patients with hypertension in Aziz Fatima Hospital, Faisalabad, which treats a substantial number of patients with stroke.

Materials And Methods

A cross-sectional study was conducted in the neurology ward of Aziz Fatimah Hospital, Faisalabad. Ethical approval was obtained from the Institutional Ethics Committee of Aziz Fatimah Hospital, Faisalabad (reference no. IEC/391-25) before the commencement of data collection. Written informed consent was obtained from all participants before enrolment. Participants were informed about the purpose of the study, the voluntary nature of participation, and their right to withdraw at any time without consequences. No personally identifiable information was collected, and participant anonymity was maintained throughout the study period. Data collection will be conducted from May to October 2025 (6 months). The study included stroke patients with hypertension who were aged ≥ 18 years, admitted to the neurology ward, had been taking antihypertensive medications for at least 6 months, and were capable of providing informed consent. Participants with comorbid conditions such as diabetes, cognitive impairment, aphasia, and coma were excluded. The sample size was calculated using OpenEpi version 3.01 with the following parameters: population size (N) = 1,000,000, expected frequency (p) = 83.8%, margin of error (d) = 5%, confidence level = 95%, and design effect (DEFF) = 1, yielding a minimum sample size of 209 participants.[11]

Potential confounding factors were age, sex, education, occupation, marital status, and residence, as these variables could independently influence both patient activation and medication adherence. The independent variable was patient activation (measured using PAM-13), and the dependent variable was medication adherence (measured using the Hill-Bone scale). These variables can be affected by sex, age, and socioeconomic status, which were therefore treated as confounding variables in the analysis. Initially, a sociodemographic form was filled out. Sociodemographic data included sex, age (five categories: 18-30 to >60 years), marital status, education, residence (rural/urban), and occupation (six categories).

Before using the Hill bone scale, permission was obtained from the author via email. A modified version of the Hill-Bone Compliance Scale (HB-HBP) was used.[12] The validity of this scale has been tested in different research.[13] This scale includes nine questions, each with four responses that are recorded as 4= all of the time, 3=most of the time, 2= some of the time, and 1= none of the time. The maximum and minimum scores were 36 and 9, respectively. A score of 9 indicates good adherence to medication, and 36 indicates poor medication adherence.[14] All participants were graded according to the following criteria, and their scores were recorded.

Patient activation was measured using the PAM-13 scale, for which permission was obtained. It includes 13 standardised questions to assess the patient's activation, capabilities, and skills. The responses to these questions included four scores: 1= strongly disagree, 2=disagree, 3=agree, 4= strongly agree, and N/A. N/A was used when the statement did not apply to any other option.[15] All responses were recorded and graded accordingly. The maximum and minimum scores were 52 and 13, respectively. Higher scores indicate that patients show greater activation in managing their own health. These 13 items were further divided into four hierarchical levels of activation: level 1 (items 1 and 2 indicating that playing an active role is important), level 2 (item 3-8 indicating presence of knowledge and confidence is needed), level 3 (item 9-11 indicating action should be taken), and level 4 (item 12-13 staying in control even in stress).[16]

Google Forms were generated, composed of 4 sections which included a consent form, a demographic form, HB-MAS, and PAM-13. Data were collected using a self-administered Google Forms questionnaire. Since the participants

completed the questionnaires independently, interviewer blinding was not applicable. No review of prior medication adherence records was performed. SPSS version 25. Continuous variables were summarised as means ± standard deviations, and categorical variables as frequencies and percentages.
Before conducting parametric analyses, the underlying statistical assumptions were verified systematically. The normality of continuous variables (PAM and Hill-Bone scores) was assessed using the Shapiro-Wilk test ($p > 0.05$ indicating normality) and visual inspection of histograms and Q-Q plots. The PAM scores demonstrated a bimodal distribution (33.5% at Level 1, 33.0% at Level 4); therefore, a non-parametric Spearman's rank correlation was also performed as a confirmatory analysis. For ANOVA, the assumptions of independence of observations, normality of residuals, and homogeneity of variances were examined. The homogeneity of variances was tested using Levene's test ($p > 0.05$ was considered acceptable). For multiple linear regression, the assumptions of linearity (assessed via scatterplots of observed versus predicted values), independence of errors (Durbin-Watson statistic; values between 1.5 and 2.5 were considered acceptable), homoscedasticity (visual inspection of residuals versus predicted values plot), and normality of residuals (Shapiro-Wilk test and Q-Q plot) were verified. All assumptions were met, except for the bimodal distribution of PAM scores, which was addressed using non-parametric confirmatory analysis, as described above. The central limit theorem (n = 209) supports the use of parametric tests for secondary analyses, but non-parametric results are reported as primary confirmatory evidence.
Frequencies and percentages were computed for sociodemographic factors, PAM activation levels (1-4), and Hill-Bone adherence classifications (high/moderate/low). For the PAM-13 scale, missing responses (coded as N/A) were handled using mean imputation, where each missing item was replaced with the participant's mean score on the answered items, as per the scale's scoring guidelines. Cases with more than 20% missing data were excluded from the analysis. The bivariate analysis comprised independent t-tests or ANOVA for comparing PAM scores among the Hill-Bone adherence categories, Pearson's correlation coefficient (r) to study the linear connection of continuous PAM and Hill-Bone scores, and chi-square tests for categorical variable associations. Multiple linear regression analysis was used to examine medication adherence (Hill-Bone score) as the dependent variable, with patient activation (PAM score), age, sex, education, occupation, marital status, and residence as independent predictors. Statistical significance was set at $P \leq 0.05$.

Results

A total of 209 patients were involved in the study, all of whom had a history of stroke, hypertension, and medication, as shown in Figure 1.

The distribution of the sample showed that there were more females, 131 (62.7%), than males, 78 (37.3%). Most of them were older than 60 years (107 persons, 51.2%), the next biggest group being those 51-60 years old (65 persons, 31.1%). The largest part of the sample was married (131, 62.7%), while 52 (24.9%) were either widowed or divorced, and 26 (12.4%) had never been married. Most of the participants had very little education, with 130 (62.2%) being totally uneducated and 36 (17.2%) having only attended primary school. In terms of occupation, 94 participants (45.0%) were unemployed, 47 (22.5%) were housewives, and 37 (17.7%) were running their own businesses. Most patients were from rural areas (127 participants, 60.8%).
Through descriptive statistics, it was found that the medication adherence levels were moderate, with Hill-Bone mean (SD) scores of 14.82 (5.90) (possible range: 9-36; observed range: 9-36). The mean (SD) patient activation score was 54.28 (14.96) (possible range: 0-100; observed range: 10-100). In most cases, medication adherence was high: 97 out of 209 participants (46.4%) showed high adherence (mean (SD) Hill-Bone score = 9.58 (1.20)), 81 out of 209 (38.8%) showed moderate adherence (17.02 (1.80)), and 31 out of 209 (14.8%) showed low adherence (25.29 (3.61)), as shown in table 1. The levels of patient activation exhibited a bimodal distribution, where 70 out of 209 were classified as Level 1 (disengaged) and 69 out of 209 as Level 4 (maintaining behaviours under stress), as shown in Figure 2.
In the one-way ANOVA, no differences in patient activation scores were found between the three categories of medication adherence. The results of the post-hoc analysis did not indicate any significant pairwise differences between the high, moderate, and low adherence groups. The average PAM scores were remarkably similar between the different categories, as shown in Table 2
Pearson correlation analysis indicated that there was no significant connection between patient activation and medication adherence ($r = .0004$, $p = 0.99$). Likewise, no demographic factors (age, sex, education, or occupation) showed significant correlations with either patient activation or medication adherence scores. Although not the primary objective, intercorrelations among demographic variables were examined to assess potential confounding factors. Significant intercorrelations were observed. Gender showed a strong positive correlation with occupation (r =

.564, p < .001), indicating gender-based occupational patterns. Education was negatively correlated with both age (r = -.141, p = 0.04) and occupation (r = -.302, p < .001), as shown in table 3.

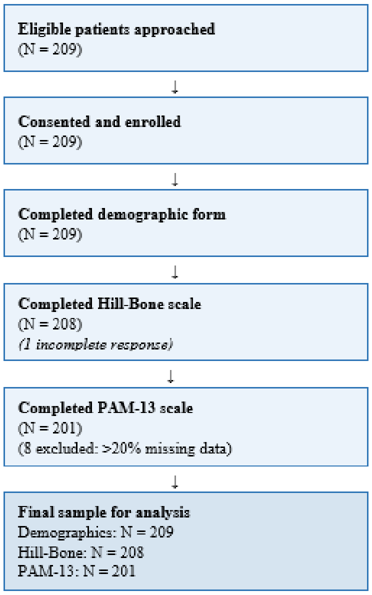

Figure 1: Patient Enrollment Flowchart

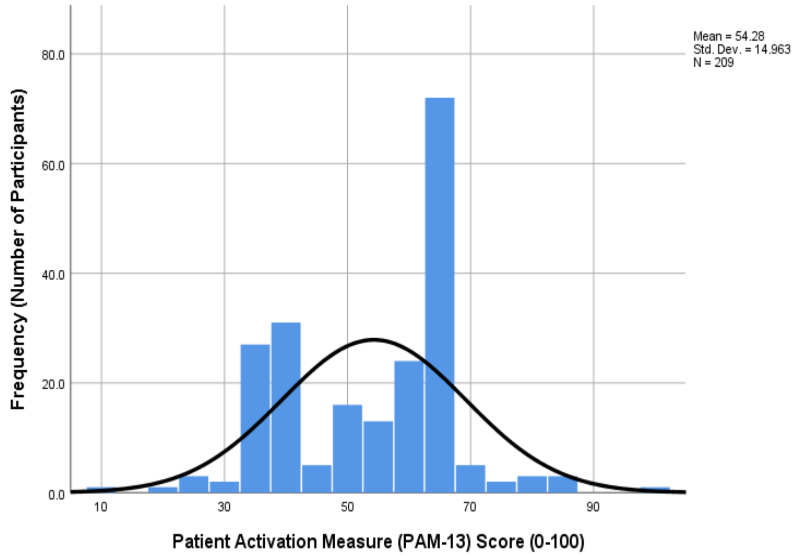

Figure 2: Distribution of Patient Activation Scores Among Stroke Patients with Hypertension (N=209)

Table 1: Distribution of Patient Activation Levels and Medication Adherence Categories

Category	n/N	%	Mean Score (SD)
PAM Activation Level			
Level 1 (Disengaged)	70/209	33.5%	14.47 (6.30)
Level 2 (Becoming aware)	22/209	10.5%	17.09 (5.86)
Level 3 (Taking action)	48/209	23.0%	14.77 (5.28)
Level 4 (Maintaining behaviors)	69/209	33.0%	14.41 (5.86)
Hill-Bone Adherence			
High Adherence (9-13)	97/209	46.4%	9.58 (1.20)
Moderate Adherence (14-20)	81/209	38.8%	17.02 (1.80)
Low Adherence (21-36)	31/209	14.8%	25.29 (3.61)

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Table 2: Comparison of Patient Activation Scores Across Medication Adherence Categories

Hill-Bone Adherence Category	n	Mean PAM Score (SD)	F-statistic (ANOVA)	p-value
High Adherence	97	54.21 (15.07)	F(2, 206) = 0.044	0.96
Moderate Adherence	81	54.59 (13.60)		
Low Adherence	31	53.68 (18.23)		

Levene's Test for Equality of Variances: F(2, 206) = 1.490, p = 0.23

Post-hoc Comparisons (Tukey HSD):

Comparison	Mean Difference	95% Confidence Interval	p-value
High vs. Moderate	-0.38	[-4.96, 5.73]	0.98
High vs. Low	0.53	[-6.79, 7.85]	0.98
Moderate vs. Low	0.91	[-6.58, 8.41]	0.95

**Note: All p-values > 0.05, indicating no significant differences between adherence categories. **

Given the bimodal distribution of PAM scores (33.5% Level 1, 33.0% Level 4), a non-parametric Spearman's rank correlation was performed to verify the robustness of the findings. Spearman's correlation confirmed no significant association between patient activation and medication adherence (ρ = 0.006, 95% CI: -0.131 to 0.143, p = 0.94), consistent with the Pearson correlation (r = 0.0004, p = 0.99). These sensitivity analyses support the conclusion that patient activation and medication adherence are not significantly associated with this bimodally distributed sample.

Multivariate Analysis: Predictors of Patient Activation

To identify predictors of patient activation, multiple linear regression was performed, taking medication adherence (Hill-Bone score) as the dependent variable and patient activation (PAM score), age, sex, marital status, education, occupation, and residence as independent variables. The model was not statistically significant ($F(7, 199) = 1.144$, $p = 0.337$) and explained only 3.9% of the variance in medication adherence ($R^2 = 0.039$, Adjusted $R^2 = 0.005$). Patient activation showed no predictive relationship with medication adherence ($\beta = -0.008$, $p = 0.91$) (Table 4).

Table 3: Correlation matrix of study variables with 95% confidence intervals

Variable	1	2	3	4	5	6	7	8
PAM Score	1							
Gender	-.055 (-.190, .082)	1						
Age	-.028 (-.163, .108)	.063 (-.073, .197)	1					
Marital Status	-.014 (-.149, .122)	.237** (.104, .362)	.214** (.079, .342)	1				
Education	.079 (-.057, .213)	-.113 (-.246, .021)	-.141* (-.273, -.005)	-.133 (-.265, .001)	1			
Occupation	.007 (-.129, .143)	.564** (.449, .662)	.065 (-.071, .199)	.110 (-.025, .242)	-.302** (-.425, -.170)	1		
Residence	-.102 (-.234, .032)	.008 (-.128, .144)	.086 (-.050, .220)	.092 (-.044, .225)	-.205** (-.335, -.069)	.105 (-.030, .237)	1	
Hill-Bone Score	.000 (-.136, .136)	-.013 (-.149, .123)	-.136 (-.268, -.001)	.092 (-.044, .225)	-.023 (-.159, .114)	.033 (-.104, .169)	.013 (-.123, .149)	1
Hill-Bone Score (Spearman ρ)	.006 (-.131, .143)	—	—	—	—	—	—	—

Note: Pearson correlation coefficients (r) with 95% CIs are presented. For the primary association between PAM Score and Hill-Bone Score, Spearman's rank correlation coefficient confirmed the null finding: ρ = 0.006 (95% CI: -0.131 to 0.143), p = 0.94.

Table 4: Multiple Linear Regression Predicting Medication Adherence (Hill-Bone Score)

Predictor	Unstandardized B	SE	Standardized β	t	p-value	95% CI for B	VIF
Constant	16.123	3.801	—	4.242	<0.001	8.63, 23.62	—
Patient Activation (PAM Score)	-0.003	0.024	-0.008	-0.112	0.91	-0.050, 0.045	1.051
Age	-0.833	0.490	-0.124	-1.700	0.09	-1.80, 0.13	1.108
Gender	-0.243	1.054	-0.020	-0.231	0.82	-2.32, 1.84	1.530
Marital Status	0.771	0.521	0.112	1.479	0.14	-0.26, 1.80	1.142
Education	0.001	0.390	0.000	0.003	0.99	-0.77, 0.77	1.164
Occupation	0.238	0.475	0.044	0.501	0.62	-0.70, 1.17	1.576
Residence	0.430	0.878	0.036	0.490	0.62	-1.30, 2.16	1.056

Model Summary: $R = 0.197$, $R^2 = 0.039$, Adjusted $R^2 = 0.005$, $F(7, 199) = 1.144$, $p = 0.337$, Durbin-Watson = 1.756.

Discussion

This study aimed to assess whether patient activation predicts medication adherence among stroke patients with hypertension. Although the participants showed moderate to high levels of medication adherence, patient activation was bimodal (level 1 and level 4). No significant association was found between patient activation and adherence to medications. Patient activation scores were consistent across the high, moderate, and low medication adherence groups. Moreover, demographic factors such as age, sex, education, and occupation had no significant influence on patient activation and medication adherence.

To our knowledge, this is the second study in the literature that explores patient activation as a predictor of medication adherence in stroke patients with hypertension. In contrast to a previous study conducted in China, which suggests patient activation was linked to better medication adherence, this study signifies no such association between the two variables.[10] The study revealed level 2 patient activation, but high and moderate medication adherence. This disparity can be explained in the context of age. Our data largely consisted of older patients. According to the findings of a study in the literature, there is a significant association between older age and medication adherence.[17] Another study on predictors of medication adherence in stroke patients found that younger age is related to poor medication adherence.[18] Younger patients might become nonadherent to medication because of stigma.[19] An additional reason for the divergence of findings is that a large portion of our sample was unemployed.

Work is inversely associated with compliance to treatment in stroke patients.[20] Hence, age and occupation in our sample size have resulted in findings that do not align with the previous study.

An important finding of this study was the bimodal distribution of patient activation, showing two extremes: Level 1 and Level 4. Level 1 patient activation can be related to a lack of education. A clinical trial found that educating patients can increase the patient activation measure.[21] Since a notable number of participants were uneducated, this explains Level 1 patient activation in most of the patients. In contrast, a significant number of patients also showed Level 4 patient activation, although most of them were uneducated. However, in a country like Pakistan, especially in rural areas, the family system is very strong. Women tend to care for the elderly, ensuring medication-taking behaviour, thus playing an informal role in their health.[22] Family support also improves medication adherence as well.[23] Thus, although the findings of this study contradict those of previous studies, they can be justified in a Pakistani setting.[10]

From a clinical and public health perspective, these findings indicate that testing patient activation alone as a predictor of medication adherence in stroke patients with hypertension in low-income countries, such as Pakistan, is insufficient. In countries like Pakistan, where the family and cultural support systems are strong, these factors should be studied alongside patient activation because family support can influence the findings.[24] This suggests that patient-activation-centred interventions in stroke patients are less effective than the family-centred approach in caregiving. A family-centred approach promises better medication adherence. [25]

This study has several strengths, from being the second study ever conducted on this topic to using validated measurement tools with high internal consistency.[12,13] However, there are certain limitations to this study. This was a single-centre study, which limits the generalisability of the findings to other studies. Moreover, patients with cognitive impairment and aphasia were excluded from the study, which limits its broader applicability to stroke patients. Medication adherence was assessed using self-reported measures, which may be subject to recall bias. The bimodal distribution of patient activation scores (with peaks at Levels 1 and 4) represents a limitation, as it violates the normality assumption of the parametric tests. However, non-parametric confirmatory analyses (Spearman's correlation and quantile regression) yielded consistent null findings, supporting the robustness of our conclusions.

Further research is needed on this topic, both globally and nationally, to better understand the findings of this study. Furthermore, other factors, such as family and social support alongside patient activation, should be explored as predictors of medication adherence in stroke patients with hypertension. Qualitative or mixed-method research could better explore such factors and provide insights into improving medication adherence by incorporating these factors into patient care.

Conclusions

This study evaluated patient activation as a predictor of medication adherence among stroke patients with hypertension and found no significant connection between them. However, there was a marked association between the demographic variables. Gender has a direct relationship with occupation, and education has an inverse relationship with age and occupation. In this population, these findings indicate that medication adherence may not be significantly influenced by self-management, awareness, or skills as interpreted by patient activation. Rather, compliance in stroke patients with hypertension was strongly affected by other factors, such as caretaker and family support. The results suggest that to improve medication adherence in stroke patients with hypertension, a broader approach that extends beyond individual-level activation and provides information about cultural, social, and health system-related factors should be adopted.

Author Information

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