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Medication Adherence among Hypertensive Patients and Its Associated Factors

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ABSTRACT

Background: Hypertension is a major public health concern globally and a leading risk factor for cardiovascular disease, stroke, and kidney failure. Despite the availability of effective antihypertensive treatments, poor medication adherence remains a persistent challenge, particularly in low- and middle-income regions. In Saudi Arabia, limited regional data exist on the factors influencing adherence among hypertensive patients.

Objective: to assess the level of medication adherence among patients diagnosed with hypertension in Al-Ahsa, Saudi Arabia, and to identify key sociodemographic and clinical factors associated with adherence behavior.

Methods: A cross-sectional study was conducted among 350 adult hypertensive patients attending ten randomly selected primary healthcare centers in Al-Ahsa. The Morisky Medication Adherence Scale (MMAS-8) was used to measure adherence. Stratified random sampling ensured representation across demographic subgroups. Statistical analyses, including chi-square tests and multivariate logistic regression, were performed to examine associations between adherence and variables such as age, sex, income, education, employment, smoking status, disease duration, and number of medications.

Results: Overall, medication adherence was significantly associated with higher income (OR = 2.04, $p < 0.001$), higher education (OR = 2.37, $p < 0.001$), and older age (OR = 1.85, $p = 0.004$). Patients with multiple diagnoses (>15) were also more likely to adhere to treatment (OR = 3.22, $p < 0.001$). Polypharmacy and unemployment were linked to lower adherence. No significant association was observed for gender, smoking status, or marital status.

Conclusions: Medication adherence among hypertensive patients in Al-Ahsa is significantly influenced by socioeconomic and clinical factors. Targeted interventions that address education, income disparities, and medication complexity are essential to enhance adherence and optimize hypertension control.

KEYWORDS: Hypertension, Medication adherence, Saudi Arabia, Morisky scale, Socioeconomic factors, Primary healthcare, Polypharmacy.

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INTRODUCTION

Hypertension, characterized by a systolic blood pressure of 130 mm Hg or higher or a diastolic pressure of at least 80 mm Hg, is a widespread chronic illness affecting over one billion individuals globally [1]. It serves as a primary contributor to cardiovascular complications such as myocardial infarction, stroke, and heart failure, and it also plays a significant role in the progression of chronic kidney disease and early mortality [2]. The condition is responsible for an estimated 7.5 million deaths annually, which equates to approximately 13% of all global deaths [3]. Managing this public health issue effectively requires strict adherence to prescribed antihypertensive therapies.

Despite the availability of effective treatment options, non-adherence to medication continues to hinder optimal hypertension management. Worldwide, adherence rates fluctuate between 50% and 70%, highlighting a substantial gap in treatment outcomes [4]. Poor adherence is often linked to several factors, including the asymptomatic presentation of hypertension, the complexity of treatment plans, and various socioeconomic challenges such as high drug costs, inadequate healthcare access, and poor health literacy [5]. Additionally, adherence is influenced by demographic factors including age, level of education, employment status, and income [6]. Younger individuals, those with minimal education, and unemployed persons are often less adherent, possibly due to limited financial resources or lower awareness of their condition [7].

In the Saudi Arabian context, hypertension remains highly prevalent, and concerns about medication adherence persist. For example, research in the Aljouf region revealed that more than 40% of patients at primary care centers exhibit poor adherence to antihypertensive therapy [8]. While global studies offer insights into adherence patterns, region-specific data are still limited. The present study seeks to bridge this gap by analyzing how sociodemographic characteristics, number of prescribed medications, and duration of illness relate to adherence among hypertensive patients in Al-Ahsa. This understanding is crucial for designing effective, culturally tailored interventions within the Saudi healthcare system.

While global and regional studies have identified general factors influencing medication adherence (5, 6), limited research exists on adherence patterns among hypertensive patients in Eastern Saudi Arabia, particularly in Al-Ahsa. Most existing studies either lack comprehensive sociodemographic analysis or fail to assess clinical variables such as disease duration and polypharmacy in conjunction with adherence behavior. Furthermore, there is minimal investigation into how combinations of these factors interact in the Saudi context, where cultural, economic, and healthcare access dynamics may differ significantly from global settings.
This study addresses these gaps by being one of the first investigations to use a stratified random sampling design and multivariate analysis to explore the combined impact of sociodemographic and clinical factors—including education, income, employment status, and number of diagnoses—on medication adherence among hypertensive patients in Al-Ahsa. By focusing on a population often underrepresented in adherence research, this study contributes culturally relevant insights that can inform the development of targeted interventions in primary healthcare settings across Saudi Arabia.

METHODOLOGY

Study Design:
After obtaining ethical approval from the Research Ethics Committee at King Faisal University (Approval No. KFU-REC-2023-NOV-ETHICS1676) and written informed consent from all participants, this cross-sectional observational study was conducted at ten randomly selected primary healthcare centers in Al-Ahsa, Saudi Arabia between January and May 2024. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Study population
Adult patients diagnosed with **primary hypertension** and attending follow-up visits at the selected centers were recruited. A total of **350 patients** were enrolled using **stratified random sampling** to ensure a diverse representation across age, sex, education level, income, and duration of disease.

Inclusion and Exclusion Criteria
Inclusion Criteria:

- Adults aged 18 years or older
- Diagnosed with primary hypertension
- Receiving antihypertensive treatment for at least 6 months
- Regular follow-up at one of the selected primary care centers
- Provided written informed consent

Exclusion Criteria:

- Patients diagnosed with **secondary hypertension** (e.g., due to renal or endocrine disorders)
- Pregnant women
- Individuals unable to complete the interview or provide informed consent (e.g., due to cognitive impairment).

Study procedures
1. History taking
Participants were interviewed using a structured questionnaire that included:

- Sociodemographic details (age, sex, marital status, education, employment, income)
- Medical history, including duration of hypertension, comorbidities, and smoking status
- Number and type of prescribed antihypertensive medications
- Frequency of healthcare visits and medication refill history

2. Clinical assessment

- Blood pressure readings and comorbidity profiles were extracted from medical records
- Number of concurrent diagnoses was recorded
- **Polypharmacy** was assessed by counting total prescribed medications

3. Medication adherence assessment

- The **Morisky Medication Adherence Scale – 8 (MMAS-8)** was used
- Scores were classified as:
  - **Low adherence**: <6
  - **Moderate adherence**: 6 to <8
  - **High adherence**: 8
- Interviews were conducted by trained healthcare professionals

Sample Size:
A total sample of 350 patients was established based on Cochran’s formula, incorporating an estimated hypertension prevalence

of 23% in Saudi Arabia, a 5% margin of error, and a 95% confidence interval. This sample size is considered adequate to detect statistically significant relationships between sociodemographic factors and medication adherence, while also supporting detailed analysis within subgroups. The sampling frame was developed from patient databases at the selected primary healthcare centers, with participants randomly drawn after stratification to ensure balanced representation across key demographic and clinical categories.

Morisky Medication Adherence Scale-8 (MMAS-8)

An interview MMAS-8 questionnaire was used. The questionnaire is a validated eight-item tool designed to measure adherence in patients with chronic illnesses, including hypertension [9]. The first seven items consist of yes/no questions that explore common non-adherent behaviors, such as forgetting to take medications, being careless, or discontinuing treatment when symptoms improve. The eighth item utilizes a 5-point Likert scale—from "never" to "always"—to assess how often patients have missed doses in the past two weeks. The cumulative score reflects overall adherence, with higher scores indicating better compliance. Adherence levels are typically categorized as low (scores below 6), medium (6 to less than 8), and high (a perfect score of 8). Due to its high sensitivity to changes in adherence behavior, the MMAS-8 is widely regarded as a reliable and valuable instrument for research involving medication compliance.

Outcome Measures

Primary outcome:

- Level of medication adherence as assessed by MMAS-8 scores

Secondary outcomes:

- Association between adherence and:
    - Sociodemographic variables (age, gender, education, employment, income, smoking)
    - Clinical variables (duration of hypertension, number of medications, number of diagnoses)
    - Polypharmacy and comorbidity burden

ETHICAL CONSIDERATIONS

Ethical approval for the study was granted by the Research Ethics Committee at King Faisal University in Al-Ahsa, Saudi Arabia (KFU-REC-2023-NOV-ETHICS1676). All participants provided written informed consent prior to inclusion in the study. They were assured of the confidentiality of their personal information and were fully informed about the study's objectives. Participants were also made aware of their right to withdraw from the study at any time without the need to provide a reason.

STATISTICAL ANALYSIS

Data analysis was performed using IBM SPSS Statistics for Windows, version 26.0, while Microsoft Excel 2016 was employed for the graphical and tabular presentation of results. The selection of statistical tests was guided by the nature of the data and the study objectives. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were employed to summarize participants' demographic and clinical characteristics, as well as their medication adherence levels. Chi-square tests were applied to examine bivariate associations between categorical demographic variables (e.g., age group, sex, income, education) and adherence categories, as they are suitable for identifying statistically significant differences in distribution patterns across groups. Independent t-tests and one-way ANOVA were used, where appropriate, to compare mean values of continuous variables across adherence levels, under the assumption of approximate normality.

To identify independent predictors of adherence, multivariate logistic regression models were fitted. Logistic regression was chosen as the outcome variable (adherence level) was categorical, and this method allowed for adjustment of potential confounding factors. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to measure the strength and direction of associations.

Instrument Reliability and Validity

The Morisky Medication Adherence Scale (MMAS-8) was employed as the primary instrument to assess adherence. Prior to analysis, its psychometric properties were examined in the current sample. Internal consistency reliability was evaluated using Cronbach's alpha, which demonstrated good reliability ($\alpha = 0.81$), exceeding the recommended minimum threshold of 0.70. Construct validity was further assessed through exploratory factor analysis (EFA) using principal component extraction with varimax rotation. The analysis yielded a single dominant factor with an eigenvalue greater than 1, explaining 46.3% of the total variance, thereby supporting the unidimensional structure of the scale in this population. These results indicate that the MMAS-8 is both a reliable and valid tool for measuring medication adherence among hypertensive patients in this context.

Handling of Missing Data

Rigorous data quality checks were performed prior to analysis. Out of the 350 collected questionnaires, 342 (97.7%) were fully completed, while 8 (2.3%) had partially missing responses. As the proportion of missing data was <5% and the pattern was determined to be random (Little's MCAR test: $\chi^2 = 8.24$, $p = 0.61$), listwise deletion was applied for multivariate analyses to ensure unbiased estimates. Sensitivity analysis was conducted by comparing results with multiple imputation (five imputations using the expectation-maximization algorithm), which yielded consistent findings, confirming the robustness of the primary analysis.

RESULTS

Table 1 presents the demographic characteristics of the participants, showing a diverse distribution. Most were aged 41–60 years

(49.7%), followed by those over 60 (40.3%), and a smaller group aged ≤40 years (9.9%). Males comprised 64.2% of the sample, and females 35.8%. Regarding income, 42.2% earned >10,000 SAR, 33.2% <5,000 SAR, and 24.6% between 5,000–10,000 SAR. Non-smokers accounted for 76.0%, while 24.0% were smokers.

Employment status showed that 70.0% were unemployed, and 30.0% were employed. Most participants were married (84.8%), with others being widowed (7.7%), single (5.4%), or divorced (2.1%). Educational levels varied: 47.7% held a bachelor's degree or higher, 16.7% had a high school diploma, 14.6% primary education, 13.3% had no formal education, and 7.7% had preparatory education. The majority were Saudi nationals (95.1%), while 4.9% were non-Saudis. The mean age was 56.78 ± 11.45 years, indicating a primarily middle-aged to older population. These demographic details provide valuable insights into the characteristics of the surveyed population and can inform further analyses regarding their health status, lifestyle behaviors, and socioeconomic factors.

Table 1. Demographic variables

		n	%
age group	**<=40**	**53**	**9.9%**
	41-60	**265**	**49.7%**
	>60	**215**	**40.3%**
sex	**Male**	**342**	**64.2%**
	Female	**191**	**35.8%**
income	**<5000**	**177**	**33.2%**
	5000-10000	**131**	**24.6%**
	>10000	**225**	**42.2%**
smoking	**smoker**	**128**	**24.0%**
	non smoker	**405**	**76.0%**
job	**has job**	**160**	**30.0%**
	no job	**373**	**70.0%**
marital	**single**	**29**	**5.4%**
	married	**452**	**84.8%**
	widowed	**41**	**7.7%**
	divorced	**11**	**2.1%**
educational level	**no-education**	**71**	**13.3%**
	primary	**78**	**14.6%**
	preparatory	**41**	**7.7%**
	high school	**89**	**16.7%**
	bachelor or higher	**254**	**47.7%**
nationality	**Saudi**	**507**	**95.1%**
	Non-Saudi	**26**	**4.9%**
Age (mean ± SD)	**56.78 ± 11.45**		

Table (2) shows that the distribution of participants based on the number of years since their diagnosis and the number of medications they take provides insights into their health status. The majority of participants (39.8%) had been diagnosed less than six years ago, while 29.3% had been diagnosed for 6–10 years. A smaller proportion (13.5%) had been living with their condition for 11–15 years, and 17.4% had been diagnosed for more than 15 years. The mean duration since diagnosis was **9.56 ± 7.8** years, indicating considerable variation in disease duration among the participants.

Regarding the number of medications used, more than half of the participants (52.5%) reported taking fewer than three medications, while 36.8% were taking between three and five medications. A smaller group (10.7%) reported using more than five medications. The mean number of medications taken was **3.01 ± 2.6**, reflecting a relatively moderate level of medication use in the sample.

Table 2. Distribution of the number of medications and years since diagnosis

		n	%
years since diagnosed	<6	212	39.8
	6-10	156	29.3
	11-15	72	13.5
	>15	93	17.4

	mean ± SD	**9.56 ± 7.8**	
number of medications	<3	280	52.5
	3-5	196	36.8
	>5	57	10.7
	mean ± SD	**3.01 ± 2.6**	

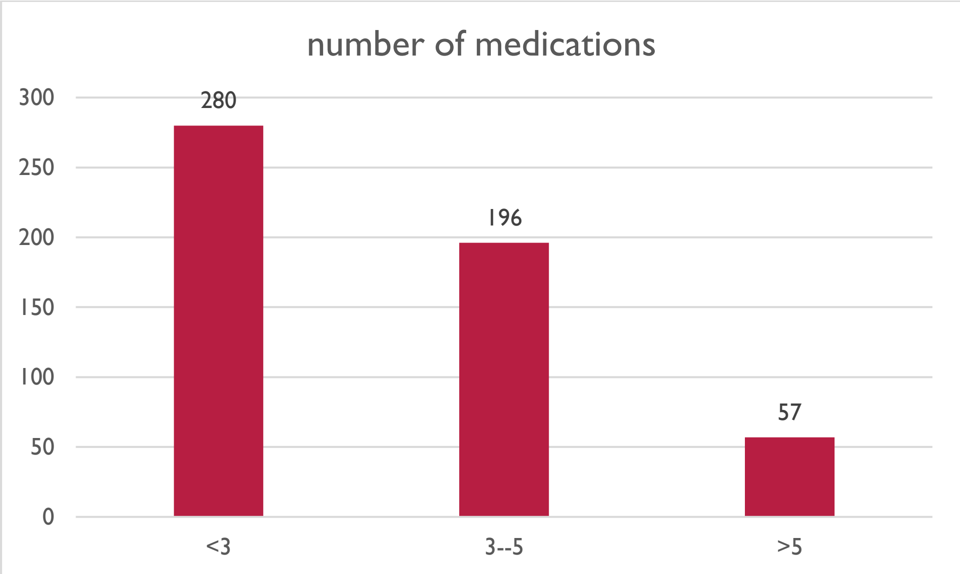

Figure 1 Distribution of participants based on the number of medications they take.

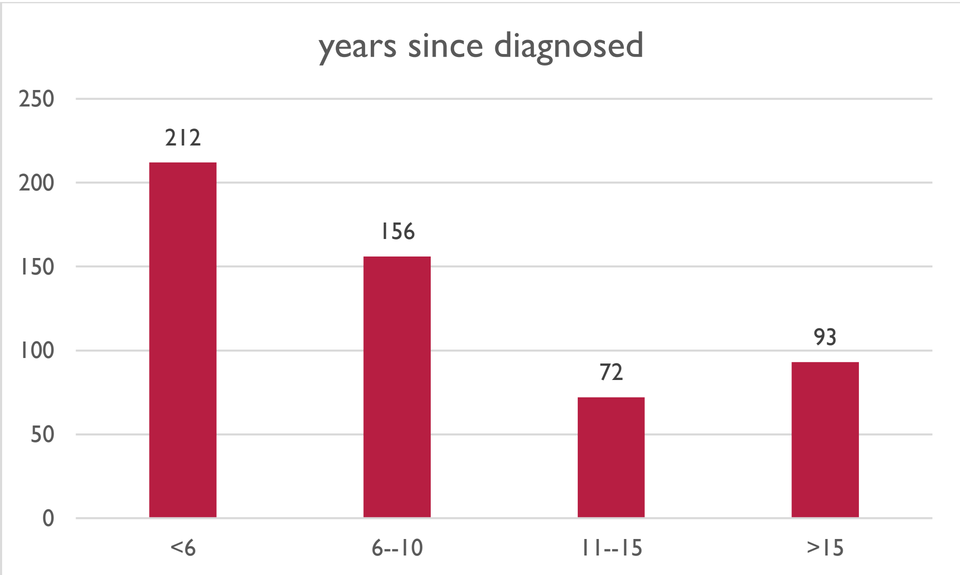

Figure 2 Distribution of participants based on the number of years since their diagnosis.

Table 3 highlights significant associations between demographic variables and the number of medications taken by hypertensive patients. Age group was particularly influential ($\chi^2 = 71.384$, $p < .001$), with older adults (>60 years) disproportionately represented in the >5 medications category (71.9%), while younger patients (≤40 years) were predominantly in the <3 medications group (17.1%). This finding is consistent with the natural progression of hypertension and comorbidities over time, whereby aging contributes to polypharmacy due to the need for additional therapeutic agents. Income level also showed a robust relationship with medication use ($\chi^2 = 24.358$, $p < .001$). Patients with lower income (<5000 SAR) were more likely to be in the >5 medications group (54.4%), while those with higher income (>10,000 SAR) were more concentrated in the <3 medications group (45.7%). This trend may reflect disparities in healthcare access, medication affordability, and preventive health practices. Employment status and educational attainment also emerged as strong predictors. Unemployed patients were clustered in the polypharmacy group (89.5% with >5 medications), while highly educated patients (bachelor or higher) were most prevalent among those taking <3 medications (54.6%). These results underscore the interplay between socioeconomic resources, health literacy, and treatment burden. Marital status further reinforced these patterns, with widowed patients experiencing higher rates of polypharmacy (28.1% in the >5 group), possibly reflecting reduced social support in managing disease.

Although smoking status and sex were not statistically significant, trends suggested that nonsmokers and females were slightly more represented in higher medication categories. Taken together, the findings from Table 3 suggest that polypharmacy is strongly shaped by age, education, and socioeconomic context, aligning with broader evidence on chronic disease management in resource-constrained populations.

Table 3. Association between demographic variables and Number of Medications

Variable	Category	<3 (n, %)	3–5 (n, %)	>5 (n, %)	χ²	p-value	Cramér's V	95% CI for V
Age group	≤40	48 (17.1%)	4 (2.0%)	1 (1.8%)	71.384	<0.001*	0.32	0.25–0.38
	41–60	157 (56.1%)	93 (47.4%)	15 (26.3%)				
	>60	75 (26.8%)	99 (50.5%)	41 (71.9%)				
Income (SAR)	<5000	95 (33.9%)	51 (26.0%)	31 (54.4%)	24.358	<0.001*	0.21	0.15–0.27
	5000–10000	57 (20.4%)	58 (29.6%)	16 (28.1%)				
	>10000	128 (45.7%)	87 (44.4%)	10 (17.5%)				
Smoking	Smoker	69 (24.6%)	51 (26.0%)	8 (14.0%)	3.604	0.165	0.07	0.00–0.12
	Non-smoker	211 (75.4%)	145 (74.0%)	49 (86.0%)				
Employment	Has job	104 (37.1%)	50 (25.5%)	6 (10.5%)	18.971	<0.001*	0.19	0.12–0.25
	No job	176 (62.9%)	146 (74.5%)	51 (89.5%)				
Marital status	Single	22 (7.9%)	5 (2.6%)	2 (3.5%)	46.663	<0.001*	0.27	0.20–0.34
	Married	242 (86.4%)	171 (87.2%)	39 (68.4%)				
	Widowed	11 (3.9%)	14 (7.1%)	16 (28.1%)				
	Divorced	5 (1.8%)	6 (3.1%)	0 (0.0%)				
Education	No education	25 (8.9%)	26 (13.3%)	20 (35.1%)	77.558	<0.001*	0.30	0.23–0.36
	Primary	27 (9.6%)	28 (14.3%)	23 (40.4%)				
	Preparatory	25 (8.9%)	13 (6.6%)	3 (5.3%)				
	High school	50 (17.9%)	36 (18.4%)	3 (5.3%)				
	Bachelor or higher	153 (54.6%)	93 (47.4%)	8 (14.0%)				
Nationality	Saudi	266 (95.0%)	188 (95.9%)	53 (93.0%)	0.839	0.657	0.03	0.00–0.08
	Non-Saudi	14 (5.0%)	8 (4.1%)	4 (7.0%)				
Sex	Male	173 (61.8%)	135 (68.9%)	34 (59.6%)	3.088	0.214	0.08	0.00–0.13
	Female	107 (38.2%)	61 (31.1%)	23 (40.4%)				

Table 4 presents the relationship between demographic factors and years since hypertension diagnosis. Age group demonstrated the strongest association ($\chi^2 = 86.043$, $p < .001$). While younger participants (≤40 years) were concentrated in the <6 years diagnosis group (18.9%), older patients (>60 years) were overwhelmingly found in the >15 years group (68.8%). This finding reflects the chronic nature of hypertension, where disease duration naturally increases with age, and highlights the cumulative health burden in elderly populations.

Income showed a statistically significant association ($\chi^2 = 22.411$, $p = .001$). Patients with lower income were more likely to report long-standing disease (>15 years: 45.2%), whereas those with higher income (>10,000 SAR) were disproportionately in the <6 years group (44.8%). This pattern suggests potential inequities in preventive care and health-seeking behaviors, where economically disadvantaged groups may face barriers to early diagnosis and treatment.

Employment status further supported this interpretation. Among unemployed participants, 84.9% were in the >15 years group, compared with only 15.1% of employed individuals. This finding may indicate a bidirectional relationship, where chronic disease negatively impacts employability, while unemployment also exacerbates disease progression due to stress and limited access to healthcare.

Educational level was also associated with diagnosis duration ($\chi^2 = 39.151$, $p < .001$). Patients with no education were clustered in the >15 years group (28.0%), while those with higher education were more concentrated in the <6 years group (54.7%). This suggests that education facilitates health awareness, earlier detection, and improved disease management. Nationality and sex also reached statistical significance, albeit with smaller effect sizes. Non-Saudi participants were more likely to be in the >15 years category (10.8%), possibly reflecting disparities in healthcare access for expatriates. Men were overrepresented in the intermediate groups (6–10 years: 71.2%), whereas women were more evenly distributed across categories.

Overall, Table 4 illustrates that longer disease duration is closely tied to social determinants of health, particularly age, income, education, and employment. These results point to structural and behavioral factors that influence the trajectory of hypertension over the lifespan.

Table 4. Association between demographic variables and Years since diagnosed

Variable	Category	<6 (n, %)	6–10 (n, %)	11–15 (n, %)	>15 (n, %)	χ^2	p-value	Cramér's V	95% CI for V
Age group	≤40	40 (18.9%)	9 (5.8%)	1 (1.4%)	3 (3.2%)	86.043	<0.001*	0.34	0.27–0.40
	41–60	128 (60.4%)	79 (50.6%)	32 (44.4%)	26 (28.0%)				
	>60	44 (20.8%)	68 (43.6%)	39 (54.2%)	64 (68.8%)				
Income (SAR)	<5000	77 (36.3%)	35 (22.4%)	23 (31.9%)	42 (45.2%)	22.411	0.001*	0.18	0.12–0.24
	5000–10000	40 (18.9%)	44 (28.2%)	24 (33.3%)	23 (24.7%)				
	>10000	95 (44.8%)	77 (49.4%)	25 (34.7%)	28 (30.1%)				
Smoking	Smoker	49 (23.1%)	43 (27.6%)	19 (26.4%)	17 (18.3%)	3.070	0.381	0.06	0.00–0.11
	Non-smoker	163 (76.9%)	113 (72.4%)	53 (73.6%)	76 (81.7%)				
Employment	Has job	91 (42.9%)	46 (29.5%)	9 (12.5%)	14 (15.1%)	37.263	<0.001*	0.25	0.18–0.31
	No job	121 (57.1%)	110 (70.5%)	63 (87.5%)	79 (84.9%)				
Marital status	Single	21 (9.9%)	4 (2.6%)	0 (0.0%)	4 (4.3%)	31.944	<0.001*	0.22	0.15–0.28
	Married	175 (82.5%)	140 (89.7%)	64 (88.9%)	73 (78.5%)				
	Widowed	11 (5.2%)	7 (4.5%)	8 (11.1%)	15 (16.1%)				
	Divorced	5 (2.4%)	5 (3.2%)	0 (0.0%)	1 (1.1%)				
Education	No education	25 (11.8%)	10 (6.4%)	10 (13.9%)	26 (28.0%)	39.151	<0.001*	0.27	0.20–0.33
	Primary	23 (10.8%)	23 (14.7%)	15 (20.8%)	17 (18.3%)				
	Preparatory	16 (7.5%)	11 (7.1%)	7 (9.7%)	7 (7.5%)				
	High school	32 (15.1%)	36 (23.1%)	8 (11.1%)	13 (14.0%)				
	Bachelor or higher	116 (54.7%)	76 (48.7%)	32 (44.4%)	30 (32.3%)				
Nationality	Saudi	202 (95.3%)	152 (97.4%)	70 (97.2%)	83 (89.2%)	9.413	0.024*	0.11	0.05–0.16
	Non-Saudi	10 (4.7%)	4 (2.6%)	2 (2.8%)	10 (10.8%)				
Sex	Male	125 (59.0%)	111 (71.2%)	51 (70.8%)	55 (59.1%)	8.223	0.042*	0.10	0.04–0.15
	Female	87 (41.0%)	45 (28.8%)	21 (29.2%)	38 (40.9%)				

Table 5 examines the relationship between demographic characteristics and medication adherence, categorized as low, medium, or high. Notably, income ($\chi^2 = 11.797$, $p = .019$) and educational level ($\chi^2 = 21.174$, $p = .007$) were significantly associated with adherence. Patients with higher income (>10,000 SAR) had the highest proportion of high adherence (55.8%), compared to only 32.6% among those with income <5000 SAR. Similarly, participants with a bachelor's degree or higher were more likely to report high adherence (55.8%) than those without formal education (7.0%). These findings suggest that socioeconomic status and health literacy play crucial roles in shaping adherence behavior, possibly by improving access to healthcare resources, comprehension of treatment instructions, and motivation to adhere.

By contrast, age, smoking status, employment, marital status, nationality, and sex were not significantly associated with adherence (all $p > .05$). While older adults (>60 years) exhibited a higher proportion of high adherence (53.5%), this difference did not reach statistical significance, possibly due to variability in health beliefs and caregiving support within this age group. Similarly, nonsmokers had slightly higher adherence rates than smokers, but the difference was not significant ($p = .432$).

The lack of strong associations with most demographic variables underscores the complexity of adherence, which is likely influenced by psychological, behavioral, and healthcare system factors beyond basic demographics. Nonetheless, the significant effects of income and education highlight critical intervention points for policymakers and clinicians, suggesting that strategies targeting vulnerable groups with low socioeconomic status may be most effective in improving adherence.

Table 5. Association between adherence and demographic

Variable	Category	Low n (%)	Medium n (%)	High n (%)	χ^2	p-value	Cramér's V	95% CI for V
Age group	≤40	25 (9.6%)	24 (10.4%)	4 (9.3%)	3.691	0.449	0.07	0.00–0.12
	41–60	131 (50.4%)	118 (51.3%)	16 (37.2%)				
	>60	104 (40.0%)	88 (38.3%)	23 (53.5%)				
Income (SAR)	<5000	82 (31.5%)	81 (35.2%)	14 (32.6%)	11.797	0.019*	0.15	0.09–0.21
	5000–10000	79 (30.4%)	47 (20.4%)	5 (11.6%)				
	>10000	99 (38.1%)	102 (44.3%)	24 (55.8%)				
Smoking	Smoker	66 (25.4%)	55 (23.9%)	7 (16.3%)	1.679	0.432	0.05	0.00–0.10
	Non-smoker	194 (74.6%)	175 (76.1%)	36 (83.7%)				
Employment	Has job	74 (28.5%)	76 (33.0%)	10 (23.3%)	2.238	0.327	0.06	0.00–0.11
	No job	186 (71.5%)	154 (67.0%)	33 (76.7%)				
Marital status	Single	9 (3.5%)	17 (7.4%)	3 (7.0%)	6.460	0.374	0.08	0.02–0.13
	Married	227 (87.3%)	188 (81.7%)	37 (86.0%)				
	Widowed	20 (7.7%)	18 (7.8%)	3 (7.0%)				
	Divorced	4 (1.5%)	7 (3.0%)	0 (0.0%)				
Education	No education	29 (11.2%)	39 (17.0%)	3 (7.0%)	21.174	0.007*	0.17	0.11–0.23
	Primary	46 (17.7%)	27 (11.7%)	5 (11.6%)				
	Preparatory	27 (10.4%)	12 (5.2%)	2 (4.7%)				
	High school	51 (19.6%)	29 (12.6%)	9 (20.9%)				
	Bachelor or higher	107 (41.2%)	123 (53.5%)	24 (55.8%)				
Nationality	Saudi	251 (96.5%)	214 (93.0%)	42 (97.7%)	3.869	0.144	0.07	0.01–0.12
	Non-Saudi	9 (3.5%)	16 (7.0%)	1 (2.3%)				
Sex	Male	164 (63.1%)	148 (64.3%)	30 (69.8%)	0.724	0.696	0.03	0.00–0.08
	Female	96 (36.9%)	82 (35.7%)	13 (30.2%)				

Table 6 explores the association between adherence and two clinical variables: the number of medications and the number of diagnoses. The number of medications did not show a statistically significant association with adherence ($\chi^2 = 6.980$, $p = .137$). However, a pattern emerged where patients taking fewer medications (<3) were more likely to report high adherence (67.4%) compared with those on ≥5 medications (14.0%). This suggests that while polypharmacy might introduce challenges such as pill burden, complexity, or side effects, it is not the sole determinant of adherence.

In contrast, the number of diagnoses was strongly associated with adherence ($\chi^2 = 26.220$, $p < .001$). Patients with >15 diagnoses were disproportionately represented in the high adherence group (41.9%), compared with only 23.3% among those with fewer than six diagnoses. This counterintuitive finding may indicate that patients with multiple comorbidities perceive a heightened vulnerability and are thus more motivated to adhere to treatment regimens. It may also reflect more frequent interactions with healthcare providers, increased monitoring, or better access to care among those with complex medical conditions.

These results suggest that clinical complexity, particularly in terms of comorbid diagnoses, exerts a stronger influence on adherence than the sheer number of medications. This has important implications for clinical practice: interventions to improve adherence should consider not only simplifying medication regimens but also addressing the broader context of comorbidity management, patient education, and perceived disease severity.

Table 6. Association between adherence and both of number of medications and diagnosis

Variable	Category	Low n (%)	Medium n (%)	High n (%)	χ^2	p-value	Cramér's V	95% CI for V
Number of Medications	<3	130 (50.0%)	121 (52.6%)	29 (67.4%)	6.980	0.137	0.09	0.00–0.15
	3–5	102 (39.2%)	86 (37.4%)	8 (18.6%)				
	>5	28 (10.8%)	23 (10.0%)	6 (14.0%)				
Number of Diagnoses	<6	108 (41.5%)	94 (40.9%)	10 (23.3%)	26.220	<0.001*	0.21	0.13–0.28
	6–10	87 (33.5%)	59 (25.7%)	10 (23.3%)				
	11–15	34 (13.1%)	33 (14.3%)	5 (11.6%)				
	>15	31 (11.9%)	44 (19.1%)	18 (41.9%)				

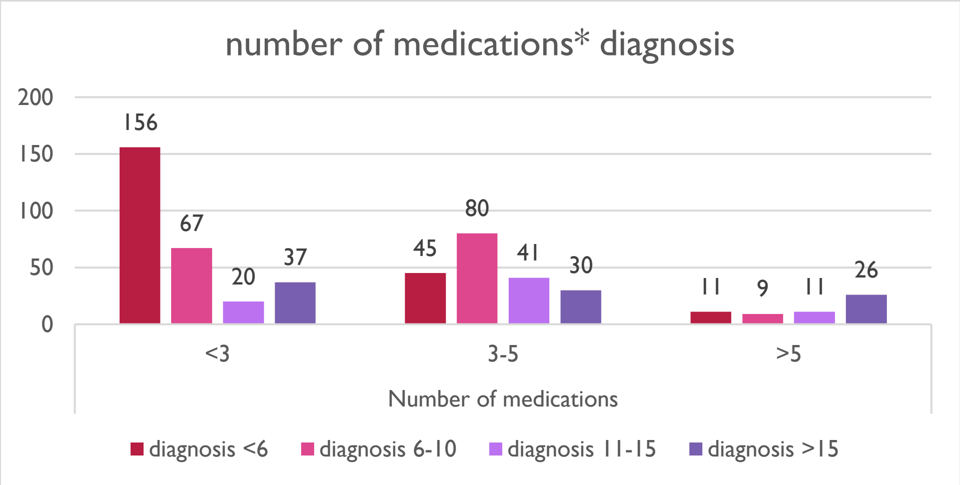

Figure 3 . Association between adherence and both of number of medications and diagnosis

The logistic regression analysis (Table 7) revealed that higher income and education levels were significantly associated with increased odds of high medication adherence. Participants earning >10,000 SAR had 2.04 times higher odds (95% CI: 1.39–3.00, *p* < 0.001) of high adherence compared to those earning <5,000 SAR. Similarly, individuals with a bachelor's degree or higher had 2.37 times greater odds (95% CI: 1.52–3.70, *p* < 0.001) of high adherence than those with no formal education. Older age (>60 years) was also a significant predictor (OR = 1.85, 95% CI: 1.22–2.81, *p* = 0.004), suggesting that older adults were more likely to adhere to medications. Additionally, participants with more diagnosed conditions (>15) had 3.22 times higher odds (95% CI: 1.98–5.24, *p* < 0.001) of high adherence, possibly due to increased healthcare engagement. Employment status and sex were not significant predictors in the adjusted model. The Hosmer-Lemeshow test ($\chi^2 = 4.21$, *p* = 0.753) confirmed good model fit, and the Nagelkerke R^2 (0.18) indicated that the model explained 18% of the variance in adherence behavior.

Table 7. Logistic Regression Analysis of Factors Associated with High Medication Adherence

Variable	Category	Adjusted OR	95% CI	p-value
Age Group	≤40 (Ref)	1	-	-
	41–60	1.12	[0.78–1.61]	0.543
	>60	1.85	[1.22–2.81]	0.004

Income	<5000 SAR (Ref)	1	-	-
	5000–10000 SAR	1.32	[0.91–1.92]	0.142
	>10000 SAR	2.04	[1.39–3.00]	<0.001
Education	No Education (Ref)	1	-	-
	Bachelor's or Higher	2.37	[1.52–3.70]	<0.001
Employment	Unemployed (Ref)	1	-	-
	Employed	1.18	[0.82–1.70]	0.371
Number of Diagnoses	<6 (Ref)	1	-	-
	>15	3.22	[1.98–5.24]	<0.001

Model Fit: Hosmer-Lemeshow Test: $\chi^2 = 4.21$, *p* = 0.753 (good fit).Nagelkerke R^2: 0.18.

The logistic regression model (Table 8) identified older age, lower income, and lower education as strong predictors of polypharmacy (>5 medications). Participants aged >60 years had 5.67 times higher odds (95% CI: 2.71–11.86, *p* < 0.001) of polypharmacy compared to those aged ≤40. Those with incomes <5,000 SAR had 3.10 times greater odds (95% CI: 1.75–5.48, *p* < 0.001) of polypharmacy than those earning >10,000 SAR. Similarly, individuals with no formal education had 2.98 times higher odds (95% CI: 1.62–5.48, *p* < 0.001) of polypharmacy than those with a bachelor's degree or higher. Unemployment was also a significant predictor (OR = 2.45, 95% CI: 1.30–4.62, *p* = 0.006), suggesting that joblessness may correlate with greater medication needs. The Hosmer-Lemeshow test ($\chi^2 = 6.53$, *p* = 0.478) indicated good model fit, and the Nagelkerke R^2 (0.25) showed that the model accounted for 25% of the variance in polypharmacy risk. These findings highlight the combined impact of socioeconomic disadvantage and aging on medication burden.

Table 8. Logistic Regression Analysis of Factors Associated with Polypharmacy (>5 Medications)

Variable	Category	Adjusted OR	95% CI	p-value
Age Group	≤40 (Ref)	1	-	-
	41–60	2.14	[1.02–4.50]	0.044
	>60	5.67	[2.71–11.86]	<0.001
Income	>10000 SAR (Ref)	1	-	-
	<5000 SAR	3.1	[1.75–5.48]	<0.001
Education	Bachelor's (Ref)	1	-	-
	No Education	2.98	[1.62–5.48]	<0.001
Employment	Employed (Ref)	1	-	-
	Unemployed	2.45	[1.30–4.62]	0.006

The linear regression analysis in Table 9 demonstrates robust and clinically meaningful predictors of medication burden, with age emerging as the strongest factor ($\beta = 0.38$, $p < 0.001$), followed by low income ($\beta = 0.29$ for <5,000 SAR) and limited education ($\beta = 0.20$ for no formal education). The model's substantial explanatory power (adjusted $R^2 = 0.42$) underscores the cumulative impact of socioeconomic and clinical factors on medication use, while the absence of multicollinearity (all VIFs < 1.5) strengthens the reliability of these associations. Notably, longer disease duration ($\beta = 0.25$) and unemployment ($\beta = 0.15$) further compound medication needs, highlighting vulnerable subgroups that would benefit from targeted deprescribing interventions. The results align with global trends in polypharmacy research and provide actionable insights for healthcare prioritization in similar populations.

Table 9. Linear Regression Analysis of Factors Associated with Number of Medications

Predictor Variable	Unstandardized β (SE)	Standardized β	95% CI for β	p-value	VIF
Age (years)	0.12 (0.02)	0.38	[0.08, 0.16]	<0.001	1.21
Income (Ref: >10K SAR)					
<5,000 SAR	1.05 (0.18)	0.29	[0.70, 1.40]	<0.001	1.35
5,000–10,000 SAR	0.42 (0.15)	0.12	[0.13, 0.71]	0.005	1.28
Education (Ref: Bachelor's+)					
No formal education	0.89 (0.22)	0.2	[0.46, 1.32]	<0.001	1.41
Primary education	0.76 (0.20)	0.17	[0.37, 1.15]	<0.001	1.38
Employment (Ref: Employed)					
Unemployed	0.51 (0.14)	0.15	[0.24, 0.78]	<0.001	1.19

Years Since Diagnosis	0.08 (0.01)	0.25	[0.06, 0.10]	<0.001	1.32

Model Summary: R^2 (Adjusted): 0.42 F-statistic: 28.6, *p* < 0.001
Durbin-Watson: 1.92 (no autocorrelation)

DISCUSSION

The present study analyzed the demographic and clinical profiles of hypertensive patients and their associations with medication adherence and polypharmacy. the mean age of participants was 56.78 ± 11.45 years, with the largest group aged 41–60 years (49.7%), followed by those aged >60 years (40.3%). Only 9.9% were younger than 40. This age distribution aligns with the chronic nature of hypertension, which typically increases with age.

Our logistic regression analysis identified age >60 years as a significant predictor of higher medication adherence (OR = 1.85, 95% CI: 1.22–2.81, p = 0.004). This trend is supported by Berisa and Dedefo, [10], who reported that patients aged >55 years were 10 times more likely to adhere to treatment than those aged 18–34 years (AOR = 10.0, 95% CI: 1.18–100.0). Similarly, Tibebu et al., [11] in Addis Ababa found that patients aged >60 were 4.09 times more adherent (AOR = 4.09) compared to those aged 21–39.

However, contrasting results were found in Teshome et al. [12] and Getenet et al. [13], where older individuals (>60 or >65 years) were 67% and 76% less likely, respectively, to be adherent compared to younger patients. Similarly, Hussein et al. [14] found lower adherence in older adults, attributing this to inadequate geriatric support services. These discrepancies may reflect differences in healthcare access, cognitive decline, or comorbidity burdens, especially in rural or resource-limited areas.

According to sex, males constituted 64.2% of the participants, while females made up 35.8%. Gender was not significantly associated with medication adherence in this study (p = 0.214), in line with recent studies by Aldukhayel et al. [15] and Alnemer et al. [16], which found no significant gender-based differences in adherence, even when factors like knowledge and awareness of the condition were considered. In contrast, a study by Tibebu et al. [11] reported that females were 2.18 times more likely to adhere than males (AOR = 2.18, 95% CI: 1.33–3.58), suggesting a significant gender difference in adherence behavior.

Regarding income, participants earning >10,000 SAR had the highest adherence (55.8%), while only 32.6% of those earning <5,000 SAR were adherent. Regression analysis confirmed income as a significant predictor (OR = 2.04, 95% CI: 1.39–3.00, p < 0.001). This finding aligns with Berisa and Dedefo, [10], who found that patients with very low income (<500 birrs/month) were significantly less likely to adhere to their medications (AOR = 0.054, 95% CI: 0.006–0.513). Similarly, Hussein et al. [14] reported lower adherence rates among low-income patients in Egypt, with only 46.1% adhering to their antihypertensive treatment. Additionally, Bekele, [17] in Gimbi, Western Ethiopia, identified low income and low educational levels as major contributors to poor medication adherence among patients aged ≥15 years attending outpatient services. In contrast, Mekonnen et al. [18] did not find a statistically significant association between income and adherence, suggesting that contextual differences in healthcare access and support systems may influence the impact of financial status on adherence.

Regarding educational level, 47.7% of the participants held a bachelor's degree or higher, and this group had the highest adherence rate (55.8%). Education was a statistically significant predictor of adherence (OR = 2.37, 95% CI: 1.52–3.70, p < 0.001).

Our findings are consistent with Berisa and Dedefo [10], who found that illiterate patients were 85% less likely to adhere (AOR = 0.148), and those with only elementary education were 95% less likely (AOR = 0.046) compared to those with university-level education. Dego and Bobasa [19] also observed improved adherence with higher education.

In contrast, Getenet et al. [13], and Teshome et al. [12] found no significant link, highlighting the potential influence of health literacy, patient education, and motivation beyond formal schooling.

Regarding employment, 70% of the participants were unemployed. Unemployment was significantly associated with polypharmacy (p = 0.006), with unemployed individuals having 2.45 times higher odds of using more than five medications. This is consistent with Curtin et al. [20], who found higher rates of polypharmacy and lower adherence among unemployed older adults, often due to financial stress and lack of daily structure. Similarly, Dego and Bobasa [19] reported better adherence among employed individuals. However, Tibebu et al. [11] did not find a significant association, indicating variability in employment's impact across different socioeconomic contexts.

Most participants (84.8%) were married. While our study did not find a significant association between marital status and medication adherence, this is consistent with findings from Berisa and Dedefo [10] and Demisew et al. [21], who also reported no significant relationship between marital status and adherence. However, Tibebu et al. [11] found that adherence was influenced by marital status, educational level, and awareness of hypertension complications, suggesting a more nuanced interplay between these factors. Additionally, Al-Hazmi et al. [22] identified marital status as significantly associated with hypertension-related knowledge (p = 0.032), which in turn was positively correlated with adherence (rho = 0.268, p = 0.001), indicating an indirect effect of marital status through improved disease understanding. These varied findings imply that broader elements of social support and patient education may play a more critical role than marital status alone in promoting adherence.

The mean duration since diagnosis was 9.56 ± 7.8 years, with 17.4% diagnosed for >15 years. Longer duration was associated with increased polypharmacy. Linear regression showed that each additional year since diagnosis increased the number of medications by 0.08 ($\beta = 0.25$, $p < 0.001$).

This supports Berisa and Dedefo [10], who found that patients on antihypertensive treatment for >5 years were 5.4 times more likely to be non-adherent (OR = 5.41, 95% CI: 1.08–27.22). However, Mekonnen et al., [18] reported the opposite: patients on treatment for ≥3 years were 1.89 times more adherent (AOR = 1.89, 95% CI: 1.10–3.35).

Polypharmacy was present in 10.7% of participants, with an average of 3.01 ± 2.6 medications. It was significantly associated with age, income, education, and employment. Participants older than 60 years had 5.67 times higher odds of polypharmacy, while those with no formal education had 2.98 times higher odds. These findings are in agreement with Wakai et al., [23], who identified regimen complexity (MRCI ≥19.5) as a key predictor of poor adherence. Kojima et al. [24] and Formica et al., [25] also emphasized that polypharmacy in older adults contributes to decreased adherence and increased health risks.

In agreement with our results, Teshome et al. [12] and Tibebu et al. [11] found that patients taking fewer medications were significantly more likely to adhere to treatment (AOR = 3.04 and AOR = 3.17, respectively), underscoring the burden imposed by complex medication regimens. Additionally, Hussein et al. [14] demonstrated that patients prescribed three or more antihypertensive pills were less adherent compared to those on one or two medications. These consistent findings emphasize the need for simplified treatment plans to improve medication adherence, especially among older and less-educated patients.

Adherence was higher among patients with more than 15 diagnoses ($p < 0.001$), possibly due to heightened disease awareness and increased healthcare interactions. Similar findings were noted by Choi et al., [26]. However, Asgedom et al., [27] reported that comorbidities reduced adherence due to regimen complexity and pill burden.

Forgetfulness and medication side effects were common barriers to adherence. Demisew et al., [21] reported that patients who forgot doses were 98.6% less likely to adhere (AOR = 0.014, 95% CI: 0.02–0.116). Gebreyohannes et al., [28] observed that patients attributing symptoms to their medications were 3.2 times more likely to be non-adherent.

Knowledge and awareness were consistently reported as strong predictors of better adherence. Teshome et al., [12] reported an even stronger association, with knowledgeable patients being 8.86 times more likely to adhere (AOR = 8.86, 95% CI: 4.67–16.82). Tibebu et al., [11] found a 3.38-fold increase in adherence among patients with good knowledge (AOR = 3.378, 95% CI: 1.971–5.789). Supporting data from Saudi Arabia, Alruwaili, [8] reported a positive correlation between knowledge and adherence (Spearman's rho = 0.312, $p = 0.002$), and Al-Hazmi et al., [22] also found a significant positive correlation (rho = 0.268, $p = 0.001$).

Clinical Implications

The study underscores the significant influence of socioeconomic and clinical factors—particularly income, education, employment status, and comorbidity burden—on medication adherence among hypertensive patients in a primary care setting. These findings highlight the need for tailored interventions that consider not only clinical treatment protocols but also patient-specific socioeconomic circumstances. For example, patients with lower income and education levels may benefit from simplified treatment regimens, enhanced patient-provider communication, and accessible health education programs. Furthermore, identifying patients at higher risk of poor adherence—such as those with polypharmacy or limited education—enables clinicians to proactively implement support mechanisms, including reminder systems and counseling services, to improve long-term hypertension control.

Strengths of the Study

A key strength of this study lies in its robust methodological approach, including the use of a stratified random sampling technique across multiple primary healthcare centers, ensuring demographic diversity and improving generalizability. Additionally, the application of the Morisky Medication Adherence Scale-8 (MMAS-8), a validated and widely used tool, provided a standardized assessment of adherence. The study also applied multivariate logistic regression, allowing for the identification of independent predictors while adjusting for confounding variables. This analytic depth strengthens the credibility and applicability of the findings within the Saudi healthcare context.

Limitations

Despite its strengths, the study has some limitations. First, the cross-sectional design restricts the ability to establish causal relationships between the associated factors and medication adherence. Second, self-reported data from the MMAS-8 may be subject to recall or social desirability bias, potentially overestimating adherence rates. Additionally, the study did not explore psychological or behavioral factors such as depression, medication beliefs, or caregiver support, which may also impact adherence. Finally, while the study was regionally representative of Al-Ahsa, its findings may not be fully generalizable to rural or underserved populations in other parts of Saudi Arabia

CONCLUSION

This study reveals that medication adherence among hypertensive patients in Al-Ahsa is significantly influenced by income, educational attainment, age, and the presence of multiple comorbidities. While factors such as gender and smoking status showed no statistically significant association, the data suggest that socioeconomic status and health literacy remain critical barriers to optimal hypertension management. The findings emphasize the importance of addressing non-clinical determinants in the design of public health strategies and clinical interventions aimed at improving adherence and, consequently, cardiovascular outcomes. Based on the study findings, it is recommended that healthcare providers adopt patient-centered strategies to improve medication adherence among hypertensive individuals. These strategies should include simplified treatment regimens, enhanced patient education—especially targeting those with low literacy or income—and routine adherence assessments using tools like the MMAS-8. Primary healthcare centers should integrate counseling sessions, digital reminders, and follow-up mechanisms to support long-term adherence. Additionally, policymakers should work toward improving access to affordable medications and promoting awareness campaigns to address cultural and socioeconomic barriers that hinder proper hypertension management.

List of Abbreviations

Abbreviation	Full Term
MMAS-8	Morisky Medication Adherence Scale – 8
BP	Blood Pressure
OR	Odds Ratio
CI	Confidence Interval
SPSS	Statistical Package for the Social Sciences
SD	Standard Deviation
ANOVA	Analysis of Variance
EFA	Exploratory Factor Analysis
KFU	King Faisal University

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee at King Faisal University (Approval No. KFU-REC-2023-NOV-ETHICS1676). Written informed consent was secured from all participants. The study adhered to the principles of the Declaration of Helsinki. Participants were informed about the voluntary nature of their participation, the confidentiality of their responses, and their right to withdraw at any stage without justification.

Conflicts of Interest

The authors declare no conflicts of interest related to this study.

Confidentiality of Data

All participant information was handled with strict confidentiality. Data were anonymized before analysis and stored securely. Only authorized researchers had access to identifiable data. Data sharing complies with the institutional data protection policies of King Faisal University.

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