

Research Article

*Journal of Traditional Medicine & Applications***Medication Adherence and Associated Factors Among Hypertensive Outpatients in Sana'a City, Yemen: A Cross-Sectional Study**Al-Maswari S N^{1*} , Adnan Ali Alradhi², Taha Ali Al Sorouri³ and Ahmed Hamood Al-Shahethi⁴¹Arab Board of Community Medicine, Medical Director of IBN Sina Hospital in Sana'a City, Yemen.²Assistant Professor of Cardiovascular Diseases Sana'a University, Yemen.³Chief Researcher at Ministry of Health, Yemen.⁴Assistant Professor of Social and Preventive Medicine 21 September University, Yemen.***Corresponding Author**

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Abstract

Background: Hypertension is the second most prevalent chronic disease in Yemen and a leading contributor to cardiovascular complications. Poor blood pressure control is often linked to low medication adherence, which remains underexplored in the country.

Objective: This study aimed to assess the level of adherence to prescribed antihypertensive medications and identify demographic, socioeconomic, knowledge, and awareness-related factors associated with adherence among hypertensive outpatients in Sana'a City, Yemen.

Materials & Methods: A cross-sectional analytical study was conducted among 398 hypertensive outpatients in three major hospitals in Sana'a (two public and one private) between October and December 2023. Data were collected through structured face-to-face interviews using a validated questionnaire, including the Morisky Medication Adherence Scale (MMAS-8) and analyzed with SPSS version 25. Descriptive statistics, bivariate analysis, and multivariate logistic regression were performed to identify independent predictors of medication adherence.

Key Results: The overall adherence rate was 12.6% (95% CI: 9.3–15.9%), indicating severely suboptimal adherence. Independent factors significantly associated with nonadherence included younger age (35–44 years: aOR = 0.08, p = 0.004; 45–54 years: aOR = 0.19, p = 0.028), illiteracy (aOR = 0.15, p = 0.023) and university education (aOR = 0.17, p = 0.019), being a housewife (aOR = 0.16, p = 0.047), diabetes comorbidity (aOR = 0.18, p = 0.008), and sedentary lifestyle (aOR = 3.84, p = 0.007). High knowledge of complications demonstrated a protective effect (aOR = 0.36, p = 0.022). Surprisingly, moderate awareness was associated with higher adherence compared with high awareness (aOR = 3.58, p = 0.038).

Key Conclusion and Recommendations: Medication adherence among hypertensive patients in Sana'a is alarmingly low, reflecting substantial challenges in chronic disease management within the current health and socioeconomic context. Younger age, educational extremes, diabetes, sedentary lifestyle, and a failure to achieve optimal self-assessment "roles were significant barriers. Multi-faceted strategies addressing behavioral modification, patient education tailored to literacy levels, strengthened counseling and Integrated care pathways services are urgently required to improve adherence and blood pressure control in Yemen.

Keywords: Hypertension, Medication Adherence, Morisky Scale, Determinants, Chronic Disease, Yemen, Cross-Sectional Study

1. Introduction

Hypertension (HTN) is a major global health challenge due to its high prevalence and its role in causing cardiovascular disease (CVD) and chronic kidney disease (CKD). It is the leading preventable risk factor for premature death and disability worldwide the global burden of HTN in 2010 was approximately 1.4 billion people and is expected to exceed 1.6 billion by 2025 [1,2]. Currently, HTN affects about 1.28 billion adults aged 30–79 years, with two-thirds living in low and middle-income countries (L-MICs). Despite its widespread prevalence, awareness, diagnosis, and treatment remain inadequate: about 46% of adults with HTN are unaware of their condition, only 42% receive treatment, and merely 21% achieve effective blood pressure (BP) control [3]. Poor BP control remains a major public health concern as it significantly increases the risk of cardiovascular events, accounting for an estimated 7.5 million deaths annually worldwide [4].

In Yemen, HTN ranks second among chronic diseases, with a prevalence of 20.5%, and 7.2% of hypertensive patients reporting a positive family history [5,6]. It is also the most common systemic disease (30.1%) among Yemeni patients listed for cataract surgery, with 82.3% newly diagnosed during screening [7]. Hypertensive heart disease is the most prevalent cardiac condition, representing 26.42% of all heart diseases [8]. Although Yemeni healthcare professionals follow the eighth Joint National Committee (JNC8) guidelines for hypertension management, uncontrolled BP remains alarmingly high (87.7%) even among treated patients [9,10]. Beyond underdiagnosis and undertreatment, non-adherence to antihypertensive medications plays a significant role in poor BP control in Yemen and globally [11]. However, there has yet to be a comprehensive assessment of medication adherence rates among hypertensive patients in Yemen. Therefore, this study aimed to assess the overall adherence levels to prescribed antihypertensive medications and its distribution by patients' demographic and socioeconomic characteristics; patients' knowledge, and awareness of HTN and determinants influencing medication adherence among hypertensive outpatients in Sana'a City to improve BP control in Yemen.

2. Material and Methods

2.1. Study Design & Setting

A cross-sectional descriptive-analytical study was carried out at the outpatient internal medicine clinics of three major hospitals in Sana'a City, Yemen: two public and one private. The public hospitals were Al-Thawra General Hospital, the largest national referral center, and Al-Kuwait University Hospital, a prominent teaching hospital. Ibn Sina Specialist Hospital represented the private sector. The study was carried out over a three-month period from October 1st to December 30th, 2023.

2.2. Study Participants

The study population consisted of hypertensive patients who were diagnosed by a specialist physician and had been on antihypertensive medication for at least one month prior to the interview. The minimum required sample size was 398 participants,

calculated using Open Epi-Info (version 3) to ensure adequate statistical power. Hospitals were allocated sample quotas using the proportional probability sample method based on size. Within each hospital, then systematic random sampling was applied to recruit the participants. Inclusion criteria included adult hypertensive patients (≥ 18 years) of both sexes who were willing to participate. Exclusion criteria were pregnant women, patients with physical disabilities, mental disorders, or dementia, those admitted to internal medicine wards or presenting with critical conditions, individuals with severe complications or comorbidities, and anyone who refused or failed to provide informed consent. Ethical clearance was obtained from the National Committee for Health and Medical Research under the Yemen Council for Medical and Health Specialization, Sana'a. Administrative permissions were obtained from the three hospitals. Verbal informed consent was obtained from all participants before data collection, during which the data collector read the informed consent letter to each participant. Participation was entirely voluntary, and all participants' data were handled securely to ensure privacy. The collected data were used solely for research purposes, maintaining strict confidentiality throughout the study.

2.3. Data Collection and Analysis

Data were collected through face-to-face interviews conducted by twelve trained postgraduate medical students with prior field experience. The study utilized a structured, closed-ended questionnaire developed based on previous validated instruments assessing HTN knowledge, medication adherence, and awareness [12–14]. The questionnaire contained 61 items distributed across five sections:

- Demographic and Socioeconomic Characteristics (12 items),
- Medication Adherence Using The 8-Item Mo Risky Medication Adherence Scale (MMAS-8),
- Knowledge of HTN Definition, Symptoms, Causes and Aggravators (22 items),
- Knowledge of Complications of Uncontrolled BP (7 items), and
- Awareness of Personal Health Status (12 items).

Reliability and validity were ensured through expert review by specialists in HTN management, cardiology, public health, and behavioral sciences. A pilot test was performed among 40 hypertensive patients to assess clarity and relevance. Ambiguous items were revised or removed, and Cronbach's alpha coefficients of ≥ 0.70 confirmed acceptable internal consistency. Data collection tools and field procedures were identical across study sites to maintain precision and comparability. Medication adherence was assessed using MMAS-8, with responses scored according to standard scoring guidelines and classified as adherent or non-adherent. Knowledge of HTN causes, symptoms and its complications were scored as high ($>75\%$), average ($50\text{--}75\%$), or low ($<50\%$). Awareness levels were categorized as high (>8), average ($6\text{--}7$), and low (≤ 5).

Data were systematically coded, subjected to double entry process, reviewed, cleaned and analyzed using SPSS (version 25). Descriptive statistics summarized participants' characteristics, and

both bivariate and multivariate analyses examined associations between adherence and demographic factors. Ethical clearance was obtained from the National Committee for Health and Medical Research (No: 98/2023) and the Yemen Council for Medical and Health Specialization, with additional approvals from Al-Thawra, Al-Kuwait, and Ibn Sina hospitals. Prior to data collection, the interviewer read an informed consent statement to each participant, ensuring that participation was entirely voluntary. All data were handled with strict confidentiality, and participants' privacy was fully respected. The collected information was used solely for research purposes, with no personal identifiers disclosed at any stage.

3. Results

3.1. Participants' Characteristics and Overall Medication Adherence

A total of 398 hypertensive outpatients participated in the study. The socio-demographic and clinical characteristics of the participants, along with corresponding medication adherence rates, are presented in Table 1. The mean age was 53.46 ± 11.95 years, indicating a population primarily composed of middle-aged and elderly adults. The largest proportion (57.2%) fell within the 45–64-year age range. Slightly more than half of the participants were males (53.5%), and most resided in urban areas (67.3%). Nearly all participants lived with their families (95.2%), and a large majority were married (80.9%).

Variable	Category	Adherence Rate n (%*)	Total n (%)
Gender	Male	30 (14.1)	213 (53.5)
	Female	20 (10.8)	185 (46.5)
Age Group (years)	25-34 years	2 (11.1)	18 (4.5)
	35-44 years	15 (20.8)	72 (18.1)
	45-54 years	18 (16.4)	110 (27.6)
	55-64 years	10 (8.5)	118 (29.6)
	>64 years	5 (6.3)	80 (20.1)
Place of Residence	Rural	10 (7.7)	130 (32.7)
	Urban	40 (14.9)	268 (67.3)
Living Arrangement	With family	49 (12.9)	379 (95.2)
	Alone	0 (0.0)	12 (3.0)
	With relatives	1 (14.3)	7 (1.8)
Marital Status	Married	41 (12.7)	322 (80.9)
	Other	9 (11.4)	76 (19.1)
Educational Level	Illiterate	10 (10.6)	94 (23.6)
	Secondary education	8 (11.9)	67 (16.8)
	University	18 (29.5)	61 (15.3%)
	Other levels	14 (8.7)	176 (44.3)
Occupation	Housewife	12 (8.9)	135 (33.9)
	Business owner	6 (7.5)	80 (20.1)
	Government employee	13 (16.5)	79 (19.8)
	Other	19 (13.7)	104 (26.2)
Monthly Family Income (YER)	< 50,000	28 (10.9)	256 (64.3)
	≥ 50,000	22 (15.3)	142 (35.7)
Duration Since HTN Diagnosis	12-36 months	15 (11.8)	127 (31.9)
	73-108 months	12 (23.5)	51 (12.8)
	Other Durations	23 (10.0)	220 (55.3)
Family History of HTN	Yes	28 (12.9)	217 (54.5)
	No	22 (12.2)	181 (45.5)
Smoking Status	Current smoker	15 (13.8)	109 (27.4)
	Non-smoker	26 (11.5)	227 (57.0)
	Former smoker	9 (14.5)	62 (15.6)
Total		50 (12.6)	398 (100.0)
*Percentages are based on subgroup totals			

Table 1: Participants' Characteristics and Medication Adherence (n = 398)

With respect to education, almost one-quarter were illiterate (23.6%), while 15.3% held a university degree. Regarding occupation, housewives (33.9%) and business owners (20.1%) formed the largest categories. Two-thirds of the households (64.3%) reported a monthly income below 50,000 Yemeni Riyals, reflecting widespread financial constraints. Clinically, 31.9% had been diagnosed with HTN for 12–36 months, and 54.5% reported a family history of the condition. In terms of lifestyle, 57.0% were non-smokers, whereas 27.4% were current smokers. The overall adherence rate to antihypertensive medication was 12.6% (95% CI: 9.3– 15.9%), indicating suboptimal adherence. Adherence patterns varied slightly across demographic groups but remained low overall. Males showed higher adherence (14.1%) than females (10.8%). Participants aged 35–44 years had the highest adherence (20.8%), while those aged 55–64 years had the lowest (8.5%). Adherence increased with education: university-educated participants showed the highest rate (29.5%), compared with only 5.6% among those with basic education.

3.2. Participants' Knowledge, Awareness, and Adherence

Participants' knowledge and awareness levels regarding HTN, its complications, and their personal health status are summarized in

Table 2, along with related adherence rates. Although knowledge levels were generally high, adherence remained poor.

3.3. Knowledge of HTN Causes, Symptoms & Triggers

Overall, 62.1% of participants demonstrated high knowledge of HTN causes, symptoms, and triggers (score > 75%). Paradoxically, adherence in this highly knowledgeable group (12.6%) was slightly lower than in the moderate knowledge group (13.3%). Recognition of specific risk factors was very high: 97.5% identified excessive salt intake, 91.7% identified obesity, and 90.5% identified smoking as aggravating factors. Yet adherence among these groups was similar - 12.9%, 13.7%, and 12.8%, respectively - indicating that widespread awareness does not necessarily translate into improved adherence. A considerable proportion also recognized genetic predisposition (71.6%), certain medications (67.3%), and Qat chewing (76.9%) as potential aggravators of HTN. However, only 54.3% correctly acknowledged that HTN may occur without symptoms, reflecting a key knowledge gap regarding the asymptomatic nature of the disease. Among those aware that HTN can be asymptomatic, adherence was 11.6%, slightly below the overall mean.

Domain/Variable	Category	Adherence Rate n (%)	Total n (%)
Overall, Knowledge (Causes, Symptoms & Triggers)	High (>75%)	31 (12.6)	247 (62.1%)
	Moderate (50-75%)	18 (13.3)	135 (33.9)
Overall, Knowledge of Complications	High (> 75%)	35 (14.7)	238 (59.8)
	Low (< 50%)	8 (19.5)	41 (10.3)
Overall Awareness (Personal Health Status)	High (≥8)	47 (14.4)	327 (82.2)
	Moderate (6-7)	3 (4.6)	65 (16.3)
	Low (≤5)	0 (0.0)	6 (1.5)
Specific Knowledge Items			
Identify excessive salt intake as increasing HTN risk	Yes	50 (12.9)	388 (97.5)
Recognize that HTN may occur without symptoms	Yes	25 (11.6)	216 (54.3)
Know That Renal Impairment as a Complication of HTN	Yes	34 (15.7)	216 (54.3)
Know That Vascular Diseases as Complications of HTN	Yes	29 (16.4)	177 (44.5)
Specific Awareness Items			
Know the target BP goal	Yes	29 (18.8)	154 (38.7)
Perceived the very importance of regular medication to control BP	Yes	50 (12.6)	397 (99.7)

Table 2: Selected Knowledge, Awareness, and Adherence Variables (n= 398)

3.4. Knowledge of Uncontrolled HTN Complications

Knowledge regarding the consequences of uncontrolled HTN was generally high. Almost all participants (98.2%) understood that untreated HTN could cause serious complications. A large proportion correctly identified major target organs: 96.2% recognized the heart, 86.7% the blood vessels, and 85.9% the kidneys as primary sites of damage. Awareness of major outcomes was also strong: 83.2% mentioned myocardial infarction and 68.1% cited cerebrovascular accidents (stroke) as possible

complications. Interestingly, participants with low knowledge of complications showed the highest adherence (19.5%), while adherence among those with high knowledge was lower (14.7%). This counterintuitive finding suggests that knowledge alone is an insufficient determinant of adherence behavior in this population.

3.5. Awareness of Current Health Status

Awareness of personal health status was relatively high. Most participants (88.9%) were aware of their diagnosis, and nearly all

recognized that BP control reduces complications (94.5%) and that regular medication use is essential (99.7%). Despite these high awareness levels, adherence remained poor. Only 39.7% could recall their initial BP reading at diagnosis, and 38.7% knew their target BP goal. Participants who knew their target BP goal, however, exhibited a higher adherence rate (18.8%) than those who did not, indicating that specific, actionable awareness may influence adherence more strongly than general knowledge.

3.6. Independent Factors Associated with Medication Adherence

Multivariate logistic regression analysis identified several independent factors associated with antihypertensive medication adherence after adjusting for potential confounders (Table 3).

3.7. Demographic and Socioeconomic Predictors

Age was a significant determinant of adherence. Compared with the reference group aged >64 years, younger participants aged 35–44 years (aOR = 0.08, 95% CI: 0.01–0.44, p = 0.004) and 45–54 years (aOR = 0.19, 95% CI: 0.04–0.84, p = 0.028) had markedly lower odds of adherence. Education displayed a non-linear pattern: both illiterate participants (aOR = 0.15, 95% CI: 0.03–0.77, p = 0.023) and university graduates (aOR = 0.17, 95% CI: 0.04–0.75, p = 0.019) were significantly less likely to adhere compared with those having secondary education. Among occupational groups, housewives demonstrated significantly lower adherence (aOR = 0.16, 95% CI: 0.03–0.97, p = 0.047). These findings highlight the complex interplay between education, socioeconomic role, and adherence behavior.

Variable	Category (Reference Group)	Adjusted Odds Ratio (95% CI)	P value
Age (years)	35–44 (>64 years)	0.08 (0.01–0.44)	0.004*
	45–54 (>64 years)	0.19 (0.04–0.84)	0.028*
Education	Illiterate (Secondary education)	0.15 (0.03–0.77)	0.023*
	University degree		
(Secondary education)	0.17 (0.04–0.75)	0.019*	
Occupation	Housewife (Reference not stated)	0.16 (0.03–0.97)	0.047*
Comorbidity	DM (No DM)	0.18 (0.05–0.63)	0.008*
Lifestyle	Sedentary lifestyle (non-sedentary)	3.84 (1.44–10.23)	0.007*
Overall, Knowledge of			
Complications (Moderate)	High (>75%)		
	0.36 (0.15–0.87)	0.022*	
	Low (<50%) (Moderate)	0.23 (0.08–0.72)	0.012*
Overall Awareness of Current Health Status	Moderate (6–7) (High		
	≥8)	3.58 (1.07–11.96)	0.038*
*Significance at p < 0.05			

Table 3: Independent Factors Associated with Medication Adherence (n=398)

3.8. Clinical, Lifestyle, and Cognitive Predictors

The presence of DM as a comorbidity was independently associated with lower adherence (aOR = 0.18, 95% CI: 0.05–0.63, p = 0.008). Sedentary lifestyle significantly increased the likelihood of non-adherence (aOR = 3.84, 95% CI: 1.44–10.23, p = 0.007), emphasizing the influence of behavioral factors. Knowledge and awareness variables also showed independent associations. High knowledge of uncontrolled HTN complications (score > 75%) was associated with reduced odds of adherence, implying a protective effect (aOR = 0.36, 95% CI: 0.15–0.87, p = 0.022). Conversely, low knowledge (score < 50%) was associated with decreased adherence (aOR = 0.23, 95% CI: 0.08–0.72, p = 0.012). A notable paradox emerged in awareness: participants with moderate awareness of their current health status (score 6–7) had significantly higher odds of adherence than those with high awareness (score ≥ 8) (aOR = 3.58, 95% CI: 1.07–11.96, p = 0.038).

This finding suggests that extremely high self-awareness may not necessarily promote adherence, possibly due to overconfidence or perceived self-control leading to inconsistent medication use.

4. Discussion

This study investigated antihypertensive medication adherence among hypertensive outpatients in Sana'a City, a critical factor for BP control in HTN [15]. Low adherence contributes to inadequate clinical parameter control and is linked to adverse health outcomes [16,17]. Non-adherence also has significant human and economic implications, causing medical and psychosocial complications, reducing quality of life, and increasing the probability of drug resistance [18].

4.1. Overall Adherence Rate and Context

The observed anti-hypertensive medication adherence rate was

critically low at 12.6%. This rate is substantially lower than reported figures from other studies conducted across the region and globally, including Ethiopia (national pooled rate of 65.1%), Saudi Arabia (17.3% to 86%), and Sudan (70.5%) [13,19-26]. This severe discrepancy highlights unique, substantial systemic or socioeconomic barriers within the Sana'a context. Potential explanations include challenges in accessing medical care, high medication costs due to conflict, fragmented care systems, and severe financial constraints, particularly given that the majority of participants reported a monthly family income below 50,000 YER.

4.2. Patient Characteristics and Medication Adherence Predictors

Multivariate analysis identified several independent predictors of non-adherence. Younger adult patients (aged 35–54 years) exhibited significantly poorer adherence compared to the oldest group (>64 years), aligning with findings from Greece, Egypt, and Saudi Arabia [27-29]. A possible explanation is that younger patients experience more competing life priorities or perceive a lower risk profile compared to the elderly. Regarding education, both illiterate and university degree holders showed significantly poorer adherence. This partially mirrors findings in Egypt but contrasts with studies in Greece and Ethiopia [19,27,28]. This complex association suggests that basic literacy barriers and high educational attainment barriers (e.g., overconfidence or stress) require different intervention approaches. Furthermore, housewives exhibited significantly poorer adherence (aOR = 0.16, $p = 0.047$), consistent with a study in Eritrea, likely due to demanding domestic responsibilities overriding self-care [30].

4.3. Lifestyle and Cognitive Factors

The study confirmed the critical role of lifestyle and clinical factors. The presence of DM was associated with significantly lower adherence, suggesting that managing multimorbidity complicates adherence (aOR = 0.18, $p = 0.008$). Conversely, a sedentary lifestyle was a strong independent predictor of adherence (aOR = 3.84, $p = 0.007$). This finding emphasizes the need to actively integrate physical activity into care plans. Crucially, a high level of knowledge about HTN complications exhibited a protective effect on adherence, consistent with international findings [27,31,32]. This suggests that understanding the severity of outcomes promotes compliance. Furthermore, the finding that patients with a moderate awareness level of their current health conditions exhibited significantly better adherence than those with high awareness (aOR = 3.58, $p = 0.038$) supports the "optimal awareness" hypothesis [33,34]. This may be because moderate awareness strikes a balance, providing sufficient risk recognition without creating the treatment burden or overconfidence associated with the highest awareness levels.

4.4. Limitations

Several limitations of this study should be acknowledged. The use of self-reported measures to assess adherence carries the risk of socially desirable responses, potentially leading to overestimated adherence levels. Additionally, multiple comparisons in the exploratory phase of the study may increase the likelihood of false-

positive associations, necessitating a more cautious interpretation of the findings.

5. Conclusions

This study establishes that antihypertensive medication adherence among outpatients in Sana'a City, Yemen, is critically low at 12.6%, pointing to a severe, unaddressed public health crisis. The findings highlight a complex web of independent factors driving noncompliance, necessitating a targeted intervention strategy. Key demographic findings show that adherence is significantly lower among younger and middle-aged adults (35–54 years) and exhibits a non-linear relationship with education, being reduced in both illiterate individuals and university graduates. This indicates that adherence barriers are not uniform but vary by educational and age groups. Occupationally, housewives also face heightened risk. Clinically, the presence of DM compounded non-adherence, while a sedentary lifestyle emerged as a dominant behavioral predictor, dramatically increasing the odds of nonadherence. A significant disconnect was identified between knowledge and behavior: general awareness of HTN consequences was high, yet compliance remained poor. Paradoxically, individuals with moderate awareness of their current health status were more adherent than those with very high awareness, suggesting that a realistic self assessment is a stronger motivator than high, potentially detached, general knowledge. These results confirm that the traditional one-size-fits-all approach is ineffective. The low overall adherence mandates the urgent implementation of multi-faceted strategies that move beyond mere information provision to focus on behavior, targeted support, and addressing core lifestyle barriers to mitigate the rising burden of cardiovascular morbidity and mortality.

5.1. Recommendations

Based on the study findings, the following urgent actions are recommended:

- **Target High-Risk Groups:** Develop specific programs for working-age adults (35–54 years) and adapt educational materials for illiterate patients and university graduates differently. Support systems must also be implemented to improve adherence among housewives.
- **Mandate Lifestyle Integration:** Healthcare providers must prescribe and rigorously follow up on physical activity alongside medication, directly addressing the sedentary lifestyle barrier. Integrated care pathways are required for managing Diabetes Mellitus and hypertension concurrently.
- **Shift Counseling to Behavior:** Move beyond factual education by using practical tools (e.g., pillboxes, reminders) and techniques to ensure consistent medication taking skills. Counseling should aim to foster a realistic perception of health risk as a stronger adherence motivator.
- **Ensure Access:** Policymakers must guarantee the continuous, affordable supply of essential antihypertensive medications to eliminate the financial barriers faced by the majority of the population.

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