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Antihypertensive medication adherence and associated risk factors among adults with hypertension: a cross-sectional study in a teaching hospital, Ghana

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Abstract

Background Hypertension remains a significant public health challenge worldwide, with an estimated 1.28 billion adults aged 30–79 years affected, two-thirds of whom reside in low- and middle-income countries. It accounts for approximately 12.8% of global mortality, and in Ghana, hypertension-induced deaths constitute about 5.2% of total mortality. One of the major challenges in hypertension management is poor adherence to antihypertensive medications, which can lead to uncontrolled blood pressure and an increased risk of complications. This study assessed medication adherence rates and predictors among patients attending the hypertension clinic at Cape Coast Teaching Hospital (CCTH) in Ghana.

Methods A cross-sectional study was conducted among 292 participants receiving care at the hypertension clinic at CCTH. Data on sociodemographic characteristics and medication adherence were collected using a semi-structured electronic questionnaire. Additionally, anthropometric measurements, systolic and diastolic blood pressure readings were recorded for all participants.

Results The mean age of the study participants was 63.1 years (SD ± 11.0), with 77.7% being female. The majority of participants were married or cohabiting (66.3%), self-employed (40.9%), and had at least a tertiary level of education (37.5%). The overall medication adherence rate was 67.8%. In multivariable logistic regression, ethnicity (non-Akan, aOR = 3.52, $p = 0.02$), regular blood pressure monitoring (aOR = 1.853, $p = 0.012$), knowledge of medications (aOR = 4.395, $p < 0.001$), dosage schedules (aOR = 5.274, $p < 0.001$) and medication availability (aOR = 4.156, $p = 0.001$) were significant predictors of antihypertensive medication adherence.

Conclusion The study revealed a moderately high adherence rate among participants. Continuous efforts to improve drug adherence regular by promoting significant predictors of adherence such as regular BP monitoring, medication availability and other patient-friendly measures are warranted.

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Keywords Hypertension, Drug adherence, Ghana, Blood pressure

Introduction

Hypertension is the primary cardiovascular risk factor and a major contributor to global mortality [1, 2]. The prevalence of hypertension varies across regions, with higher rates in low- and middle-income countries. According to the World Health Organization's fact sheet, as of 2023, an estimated 1.28 billion adults aged 30–79 years are living with hypertension, with the increase observed largely in low- and middle-income countries [3]. In particular, the continent of African has the highest prevalence of hypertension (27%) cases [4, 5]. In 1990, the number of hypertension cases in Africa was approximately 54.6 million [6]. This number increased to 130.2 million in 2020, and it is expected to reach 216.8 million by the year 2030 [6].

The high prevalence of hypertension in Africa is coupled with low rates of detection, treatment, and control [4, 7]. However, this trend belies the availability of cost-effective strategies to manage hypertension and prevent serious health outcomes and programmatic interventions that are in place. Less than half of adults living with hypertension are diagnosed and treated, and only approximately 1 in 5 have their condition under control [8]. Hypertension management often requires a multifaceted approach that includes both pharmacological therapy and lifestyle modifications [9].

Globally the prevalence of medication non-adherence is estimated to be 45.3%, but the prevalence of African is as high as 62.5% [10]. Pharmacologically, antihypertensive medication regimens are effective in managing hypertension and its related health problems if patients adhere to antihypertensive drug regimens [11]. Janz and Bexker define drug adherence to long-term therapy as the extent to which a person's behavior-taking medication, following a diet, and/or executing lifestyle changes correspond with agreed recommendations from a healthcare provider [12].

Adherence to antihypertensive medication is crucial for managing hypertension and preventing complications. Boima et al. reported that patients who consistently take antihypertensive medication tend to have well-controlled blood pressure [13]. However, adhering to hypertension treatment can be difficult, especially because the disease often has no noticeable symptoms [14]. Patients with uncontrolled hypertension, because of their poor adherence with medications, remain at risk for serious morbidity and mortality, thereby accounting for a significant cost and burden through avoidable hospital admissions, premature deaths, work absenteeism, and reduced productivity [15].

Therefore, it is not surprising that blood pressure control is generally poor among hypertensive patients in sub-Saharan Africa [16]. A similar situation is observed in Ghana, which is largely due to nonadherence with antihypertensive therapy [17]. A study conducted by Obirikorang and colleagues in the Kintampo Municipality, Ghana, indicated that the prevalence rate of nonadherence among hypertensive individuals was 58.6%, and this value was even lower than that reported in other studies conducted in the country [17]. Factors such as cost, side effects, and a lack of understanding of the importance of medication adherence contribute to suboptimal hypertension control [16]. In Ghana, these factors are no different, as the prevalence of hypertension continues to rise [18]. Hypertension is one of the most common chronic diseases in Ghana and is a growing health burden. In 2010, the prevalence of hypertension in Ghana ranged from 19% to 48%, with a higher prevalence in urban areas [19]. According to the Ghana Health Service (GHS), in 2017, hypertension was among the top ten causes of mortality from all ages [20]. In 2023, the World Health Organization (WHO) reported that 3.2 million Ghanaian adults aged 30-79 years had hypertension, representing 34% of the population in this age groups [21]. The estimated number of people living with hypertension as of 2022 was 622,849 [22]. A global report on hypertension by the WHO revealed that 190,000 people died from hypertension in Ghana in 2019 [23]. While previous studies have examined antihypertensive medication adherence in Ghana, gaps remain in understanding the specific factors influencing adherence in different healthcare settings and patient populations. This study aims to investigate antihypertensive medication adherence and associated risk factors for medication non-adherence among out-patients at the Cape Coast Teaching Hospital.

Methodology

Study design and setting

This cross-sectional study was conducted at the Cape Coast Teaching Hospital (CCTH) located in the northern part of Cape Coast from April to December 2023. The hospital has a 400-bed capacity and serves as the major source of healthcare for the indigens of the region, a referral site for hospitals in the Central and Western Regions of Ghana as well as a teaching hospital for the University of Cape Coast School of Medical Sciences. The hospital runs a hypertensive clinic every Tuesday from physicians, and dieticians. On average, the hypertensive outpatient department (OPD) attendance for the hospital in a year is approximately 9305 (unpublished

data: Lightwave Health Information Management System (LHIMS) Records of CCTH).

Study participants and sampling

Study participants were conveniently selected for the study: according to the sampling protocol, patients attending routine hypertension clinic during the study period were assigned sequential numbers, and every even-numbered client was invited to join the study in order to reduce systematic bias to ensure the inclusion of participants who met specific study criteria and could provide relevant information related to the research objectives. Individuals who were 18 years and above, had been diagnosed with hypertension for at least one year, were receiving treatment by taking one or more oral antihypertensive medications, were willing to participate in the study and signed a consent form were included in this study. Individuals younger than 18 years, those without a confirmed diagnosis of hypertension, patients with severe cognitive impairments, communication difficulties, or serious mental illness that could interfere with participation, as well as those who declined to provide consent, were excluded from the study. Pregnant women were also excluded to avoid confounding pregnancy-related hypertension with chronic hypertension.

Sample size

The sample size calculation was adapted from a previous study by Bosu et al. with modifications to suit the current research [19]. To achieve a 5% precision rate in estimating the proportion of patients adhering to their antihypertensive medication regimen, the minimum required sample size was calculated to be 290. The single proportion formula was used for this determination:

$n = \frac{z^2 p(1-p)}{E^2}$, where n is the minimum sample size, z is the standard normal distribution critical value (1.96) for a 95% confidence interval (CI), p is the estimated proportion of adherence in the study population (set at 30%) [24, 25], and E represents the margin of error (set at 5%).

Data sources

Data were collected via a semi-structured questionnaire and patient records. The questionnaire was designed for this study and tailored to the Ghanaian context (Supplementary Material 1). Questionnaires were translated to Akan or other languages as required during interviews The instrument comprised multiple sections: Part A elicited socio-demographic information (age, sex, education, occupation, income, marital status, and place of residence); Part B captured medical history, including duration of hypertension, family history, blood pressure monitoring practices, lifestyle factors (smoking, alcohol, coffee consumption), and comorbidities; and Part C assessed factors influencing adherence such as treatment duration, number and knowledge of prescribed drugs, drug availability, adherence patterns, and reasons for non-adherence. Part D assessed the knowledge about hypertension. Part E recorded anthropometric measurements (weight, height, waist circumference, body mass index) and blood pressure readings, while Part F included clinical data on fasting and random blood glucose, total cholesterol, triglycerides, high density lipoproteins (HDL), and low-density lipoproteins (LDL) levels. This data was obtained from patients' medical records as documented during their routine clinic visits. The cut-off values for abnormal fasting and random blood glucose were based on WHO criteria (≥5.6 mmol/L for FBG and ≥7.8 mmol/L for RBG) [26].

Information on tobacco and alcohol use was obtained using structured questions adapted from the WHO STEPwise approach to noncommunicable disease risk factor surveillance [27]. Participants were asked whether they currently smoke any tobacco products (cigarettes, cigars, or pipes) and, if so, the average number of cigarettes smoked per day and duration of smoking in years. Current smokers were defined as those who reported smoking either regularly or occasionally at the time of the study, while former smokers were those who reported quitting. Alcohol consumption was assessed by asking participants whether they had ever consumed alcoholic beverages (beer, wine, spirits, bitters, palm wine, or akpeteshie) and whether they drink regularly (defined as at least once per month for the past six months). Current drinkers were defined as those who met this criterion, former drinkers as those who had stopped drinking, and non-drinkers as those who reported no history of alcohol use [27].

Medication adherence was defined as the degree to which a patient correctly follows medical advice regarding prescribed medications, including timing, dosage, and frequency and assessed via self-report [28]. Adherence was assessed using the item, "Do you regularly take your medications? (Yes/No)," with "Yes" classified as adherence and "No" as non-adherence. Awareness of drug use was evaluated by the questions, "Do you know the medications you are on? (Yes/No)" and "Do you know the dosages? (Yes/No).". The questionnaire was pretested for reliability and validity in a non-study area to determine the reactions of the respondents to the research procedures. The patient's drug history was verified from the patient's folder. The fasting or random blood glucose results were collected from the patient's folder depending on availability.

Enrolment procedure and data collection

At enrolment, written informed consent was obtained from each participant after the study's purpose and

procedures had been explained. Data was collected using a semi-structured electronic questionnaire created in the Kobo Toolbox platform. The questionnaire was administered in person through face-to-face interviews conducted by the principal investigator and a research assistant, both of whom had received training on the study protocol, ethical considerations, and standardized measurement techniques. The interviewers ensured that each respondent fully understood the questions before providing responses, which were recorded directly into electronic forms.

Anthropometric measurements

Anthropometric measurements (weight and height) and blood pressure were taken for all participants using calibrated equipment. Weight was measured with participants wearing light clothing and no shoes, using a calibrated digital scale. Height was measured with a wall-mounted stadiometer, with participants standing upright without shoes. Blood pressure was measured with an automated digital sphygmomanometer, with participants seated comfortably, back supported, feet flat on the floor, and the left arm supported at heart level. Participants rested for at least five minutes before the first reading, and two measurements were taken at 1–2-minute intervals; the average of the two readings was recorded.

The height and weight of each participant were measured. The body mass index (BMI) of each participant was then calculated by dividing the weight in kilograms by the square of the height in meters and categorized according to [27] criteria into normal weight (BMI 18.5–24.9 kg/m^2), underweight (<18.5 kg/m^2), overweight (25.0–29.9 kg/m^2) and obese (≥30.0 kg/m^2) [29, 30].

Blood pressure was measured after 3–5 min of rest. The average of two blood pressure readings for the study participants was taken and recorded. The blood pressures were then classified into systolic and diastolic blood pressures according to the WHO classification [30]. High systolic blood pressure (SBP) was defined as a systolic blood pressure greater than or equal to 140 mmHg, whereas high diastolic blood pressure (DBP) was defined as a diastolic blood pressure greater than or equal to 90 mmHg [30]. The mean arterial pressure (MAP) was calculated via the formula DBP + 1/3(SBP − DBP) [31]. MAP of 70 to 100 mmHg was considered normal [32].

Statistical analysis

Data from Kobo Toolbox were extracted via Microsoft Excel spreadsheet 2018 and analyzed using the IBM Statistical Package for the Social Sciences (SPSS) version 30. Cases with missing data were excluded from the analysis (listwise deletion). Frequencies and percentages were used to assess the participants' characteristics. The chi-square test was performed to determine the associations among sociodemographic characteristics, clinical characteristics, blood pressure measurements, blood glucose levels, and knowledge of hypertension with antihypertensive medication non-adherence. Open-ended responses on "Awareness and Knowledge About Hypertension" were coded as correct or incorrect, and the frequencies and percentages of correct responses were summarized to assess participants' knowledge and awareness levels.

Additionally, multivariable logistic regression was performed with adherence as the outcome variable to identify predictors including sociodemographic factors (ethnicity, monthly income), medical history (monitoring blood pressure, coffee consumption), medication purchase patterns (knowledge of dosage and name, medication availability), and perceptions of antihypertensive medication use, enabling the estimation of adjusted odds ratios while controlling for potential confounders. Associations were deemed statistically significant if the p-value was less than 0.05.

Results

Sociodemographic characteristics of participants

A total of 300 participants were enrolled in the study; however, after data cleaning, only data from 292 participants were included in the final analysis. The mean age of participants was 63.1 years (SD = 11.0). In terms of gender distribution, 77.7% participants were female, while Ethnic representation was predominantly Akan (88.4%), followed by smaller proportions of Ewe (0.7%), Ga-Adangme (1.4%), Guan (0.3%), Mole-Dagbani (1.4%), and other ethnic groups (7.8%). Regarding place of residence, 66.7% of participants lived in urban areas. Marital status data indicated that 66.3% were married or cohabiting, while 33.7% were single, divorced, or widowed. Educational attainment varied, with 16.5% having no formal education, 25.8% completing basic education, 20.3% attaining secondary or senior high school education, and 37.5% holding tertiary education qualifications. Employment status showed that 9.6% were employed, 40.9% were self-employed, 40.5% were unemployed, and 8.9% were pensioners. Household size distribution revealed that 64.4% of participants lived in households with fewer than five people. Income levels varied, with 54.2% earning below 1000, while 45.8% earned above this threshold (supplementary sheet; Table 1).

In univariable analysis, ethnicity was significantly associated with adherence, χ^2 (1, N = 292) = 5.39, p = 0.020, with non-Akan individuals having higher adherence (85.3%) compared to Akan participants (65.5%) (OR = 3.694, 95% CI [1.033, 13.212]). Income level also influenced adherence, χ^2 (1, N = 292) = 6.431, p = 0.011, with participants earning below 1000 currency units adhering more than those earning above 1000 (72.8% vs. 55.2%) (OR = 0.457, 95% CI [0.247, 0.844]). Other

Table 1 Sociodemographic characteristics and factors associated with medication adherence among study participants

Parameter	Adherence Status			X2-Value/T-Statistic, df	*P*-Value	OR [95% C.I.]	aOR [95% C.I.]
	Non-Adherence	Adherence	Total				
Total	94(32.2%)	198(67.8%)	292(100.0%)				
Age	63.9±10.865	62.8±10.901	63.1±11.0	0.772, 281	0.441		
Gender							
Male	21(32.3%)	44(67.7%)	65(22.3%)	0.001, 1	0.982		
Female	73(32.2%)	154(67.8%)	227(77.7%)				
Ethnicity							
Akan	89(34.5%)	169(65.5%)	258(88.4%)	5.39, 1	**0.02**	Reference	Reference
Non-Akan	5(14.7%)	29(85.3%)	34(11.6%)			3.694 [1.033 - 13.212]	3.52[0.973 - 12.733]
Place of Residence							
Rural	25(25.8%)	72(74.2%)	97(33.3%)	2.560, 1	0.11		
Urban	68(35.1%)	126(64.9%)	194(66.7%)				
Marital Status							
Married / Cohabiting	58(30.1%)	135(69.9%)	193(66.3%)	0.958, 1	0.328		
Single/ Divorced/ Widowed	35(35.7%)	63(64.3%)	98(33.7%)				
Education Level							
No formal education	10(20.8%)	38(79.2%)	48(16.5%)	3.506, 3	0.32		
Basic education	26(34.7%)	49(65.3%)	75(25.8%)				
Secondary/ Senior High education	21(35.6%)	38(64.4%)	59(20.3%)				
Tertiary Education	37(33.9%)	72(66.1%)	109(37.5%)				
Employment Status							
Employed	7(25.0%)	21(75.0%)	28(9.6%)	3.150, 3	0.369		
Self employed	39(32.8%)	80(67.2%)	119(40.9%)				
Unemployed	36(30.5%)	82(69.5%)	118(40.5%)				
Pensioner	12(46.2%)	14(53.8%)	26(8.9%)				
Number of people in Household							
Below 5	68(35.6%)	123(64.4%)	191(65.4%)	2.942, 1	0.086		
5 and above	26(25.7%)	75(74.3%)	101(34.6%)				
Average Income							
Below 1000 Ghc	28(27.2%)	75(72.8%)	103(54.2%)	6.431, 1	**0.011**	Reference	Reference
Above 1000 Ghc	39(44.8%)	48(55.2%)	87(45.8%)			0.457 [0.247 - 0.844]	0.395[0.206 - 0.760]

Data is presented as frequency and percentage in parenthesis, f(%). X2-Value – Chi square value, df – degree of freedom, aOR – adjusted odds ratio, C.I. – confidence interval. *P*-Value – probability value. *P*-Value < 0.05 is considered statistically significant. OR adjusted for age, gender and other significant variable. Value in bold indicate statistically significant results.

sociodemographic factors, including gender, residence, marital status, education level, employment status, and household size, were not significantly associated with adherence (supplementary sheet, Table 1).

Medical history of participants

The average blood pressure among participants was elevated, with a mean systolic pressure of 143.5 mmHg and diastolic of 86.8 mmHg. The mean MAP was 105.36 (SD ± 14.78). Fasting blood glucose averaged 6.1 mmol/L, and random glucose 8.1 mmol/L, suggesting possible issues with blood sugar control in some individuals. Most participants (74.3%) had been living with hypertension for five or more years, and 66.0% had a family history of the condition. Only 47.9% of participants monitored their blood pressure, and among them, 62.1% did so regularly. Smoking was rare (0.7%), and only 15.6% reported drinking alcohol. Coffee consumption was also low (4.1%), with most drinkers having consumed it for 10 years or less. About one-third (33%) had other health conditions. Diabetes was the most common comorbidity (58.3% of those affected), followed by asthma (34.4%) and other less common issues like peptic ulcers, glaucoma, eye problems, and others (supplementary sheet; Table 2).

Home-based blood pressure monitoring was significantly associated with adherence, χ^2 (1, N = 292) = 6.373, p = 0.012, with those who monitored regularly being 1.9 times more likely to adhere (OR = 1.903, 95% CI [1.151,

Table 2 Association between participants' medical history and medication adherence

Parameter	Adherence Status			X2-Value, df	*P*-Value	OR [95% C.I.]	aOR [95% C.I.]
	Non-Adherence	Adherence	Total				
Duration of hypertension							
below 5 years	27(36.5%)	47(63.5%)	74(25.7%)	0.945, 1	0.331		
5 or more years	65(30.4%)	149(69.6%)	214(74.3%)				
Family history of hypertension							
No	21(24.4%)	65(75.6%)	86(34.0%)	1.959, 1	0.162		
Yes	55(32.9%)	112(67.1%)	167(66.0%)				
Monitor blood pressure							
No	59(38.8%)	93(61.2%)	152(52.1%)	6.373, 1	**0.012**	Reference	Reference
Yes	35(25.0%)	105(75.0%)	140(47.9%)			1.903 [1.151 - 3.147]	1.853[1.114 - 3.083]
Frequency of monitoring							
Regularly	27(31.0%)	60(69.0%)	87(62.1%)	6.144, 2	**0.046**	Reference	Reference
Once I remember	3(9.1%)	30(90.9%)	33(23.6%)			4.5 [1.263 - 16.036]	4.108[1.147 - 14.718]
Seldomly	5(25.0%)	15(75.0%)	20(14.3%)			1.35 [0.445 - 4.094]	1.513[0.478 - 4.784]
History of Smoking							
No	57(38.3%)	92(61.7%)	149(99.3%)	0.617, 1	0.432		
Yes	0(0.0%)	1(100.0%)	1(0.7%)				
Alcohol consumption							
No	76(31.1%)	168(68.9%)	244(84.4%)	0.340, 1	0.560		
Yes	16(35.6%)	29(64.4%)	45(15.6%)				
Take coffee							
No	86(30.9%)	192(69.1%)	278(95.9%)	3.964, 1	**0.046**	Reference	Reference
Yes	7(58.3%)	5(41.7%)	12(4.1%)			0.320 [0.099 - 1.037]	0.346[0.020 - 5.965]
Presence of comorbidity							
No	56(30.1%)	130(69.9%)	186(66.0%)	0.534, 1	0.465		
Yes	33(34.4%)	63(65.6%)	96(34.0%)				

Data is presented as frequency and percentage in parenthesis, f(%). X2-Value – Chi square value, df – degree of freedom, OR – odds ratio, C.I. – confidence interval. *P*-Value – probability value. *P*-Value < 0.05 is considered statistically significant.Value in bold indicate statistically significant results.

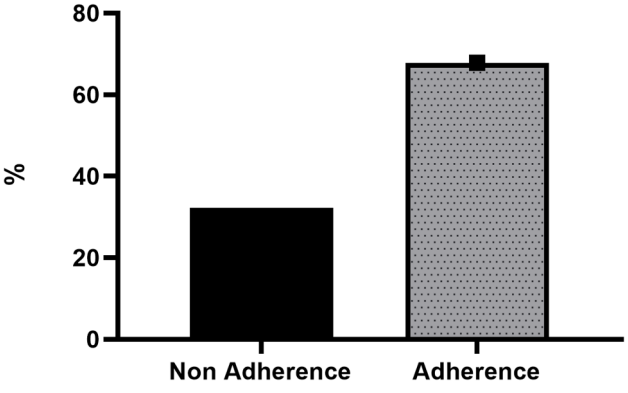

Fig. 1 Reported Medication Adherence Levels among Participants

3.147]). Frequency of monitoring also played a role, $\chi^2(2, N = 292) = 6.144$, $p = 0.046$, as participants who checked their blood pressure "once they remembered" were 4.5 times more likely to adhere compared to those who monitored regularly (OR = 4.5, 95% CI [1.263, 16.036]) (supplementary sheet; Table 2).

Reported medication adherence levels among participants

Figure 1 presents the distribution of reported medication adherence among participants. The majority (67.8%) adhered to their prescribed medication regimen, while 32.2% exhibited non-adherence.

Participants' medication behavior

Among those receiving treatment for hypertension, most (73.6%) had been on treatment for at least five years, and 66% were taking more than three medications. About 73.0% knew the names of their medicines, and 79.7% were on a once-daily dose. Most participants (70.9%) were aware of their correct dose. Side effects were reported by 16.8% of participants, with common issues including frequent urination (4.3%), sexual problems (4.0%), and general body weakness (3.0%). In terms of getting their medications, 45% used the National Health Insurance Scheme (NHIS), 28.2% paid out-of-pocket, and 26.8% used both NHIS and personal funds. Medication availability was high, with 92.5% saying their drugs were easy to access (supplementary sheet, Table 3).

Participants who knew their medications were significantly more likely to adhere, χ^2 (1, $N = 292$) = 29.736, $p < 0.001$ (OR = 4.395, 95% CI [2.532, 7.627]) (Table 6). Similarly, knowing the correct dosage was associated with higher adherence, $\chi^2(1, N = 292) = 38.321$, $p < 0.001$ (OR = 5.274, 95% CI [3.047, 9.131]). The presence of

Table 3 Medication purchase and perception factors associated with medication adherence

Parameter	Adherence Status			X2-Value, df	*P*-Value	OR [95% C.I.]	aOR [95% C.I.]
	Non-Adherence	Adherence	Total				
Duration of being on hypertension treatment							
Below 5 years	30(39.0%)	47(61.0%)	77(26.4%)	2.195, 1	0.138		
5 years and above	64(29.8%)	151(70.2%)	215(73.6%)				
Number of drugs being taken							
1	5(23.8%)	16(76.2%)	21(7.2%)	8.602, 4	0.072		
2	35(44.9%)	43(55.1%)	78(26.8%)				
3	29(25.9%)	83(74.1%)	112(38.5%)				
4	13(29.5%)	31(70.5%)	44(15.1%)				
5 or more	12(33.3%)	24(66.7%)	36(12.4%)				
Do you know your medications							
No	44(56.4%)	34(43.6%)	78(27.0%)	29.736, 1	**<0.001**	Reference	Reference
Yes	48(22.7%)	163(77.3%)	211(73.0%)			4.395 [2.532 - 7.627]	0.873[0.261 - 2.924]
Frequency of obtaining drug							
1 per day	73(31.5%)	159(68.5%)	232(79.7%)	0.366, 1	0.545		
2 or more	21(35.6%)	38(64.4%)	59(20.3%)				
Awareness of dosage(s) of medication(s)							
No	49(58.3%)	35(41.7%)	84(29.1%)	38.321, 1	**<0.001**	Reference	Reference
Yes	43(21.0%)	162(79.0%)	205(70.9%)			5.274 [3.047 - 9.131]	6.483[1.993 - 21.084]
Presence of side effect(s)							
No	63(28.5%)	158(71.5%)	221(75.9%)	10.311, 2	**0.006**	Reference	Reference
Yes	18(36.7%)	31(63.3%)	49(16.8%)			0.687 [0.358 - 1.316]	0.750[0.368 - 1.531]
I don't know	13(61.9%)	8(38.1%)	21(7.2%)			0.245 [0.097 - 0.621]	0.143[0.053 - 0.385]
How drug is obtained							
NHIS	38(29.0%)	93(71.0%)	131(45.0%)	4.396, 2	0.111		
Self-purchase	34(41.5%)	48(58.5%)	82(28.2%)				
Partial NHIS covers and purchase the rest	22(28.2%)	56(71.8%)	78(26.8%)				
Availability of the drugs							
Not readily available	14(63.6%)	8(36.4%)	22(7.5%)	10.777, 1	**0.001**	Reference	Reference
Readily available	80(29.6%)	190(70.4%)	270(92.5%)			4.156 [1.678 - 10.295]	2.622[0.946 - 7.271]

Data is presented as frequency and percentage in parenthesis, f(%). X2-Value – Chi square value, df – degree of freedom, OR – odds ratio, C.I. – confidence interval. *P*-Value – probability value. *P*-Value < 0.05 is considered statistically significant. Value in bold indicate statistically significant results.

complications also influenced adherence, $\chi^2(2, N = 292) = 10.311$, $p = 0.006$, with those unaware of complications being less adherent (OR = 0.245, 95% CI [0.097, 0.621]). Medication availability strongly influenced adherence, $\chi^2(1, N = 292) = 10.777$, $p = 0.001$, as participants with readily available medications were 4.16 times more likely to adhere (OR = 4.156, 95% CI [1.678, 10.295]) (supplementary sheet, Table 3).

Multivariable analysis

In multivariable logistic regression, ethnicity (non-Akan, aOR=3.52, p=0.02), regular blood pressure monitoring (aOR=1.853, p=0.012), knowledge of medications (aOR=4.395, p<0.001), dosage schedules (aOR=5.274, p<0.001) and medication availability (aOR=4.156, p=0.001) were significant predictors of antihypertensive medication adherence (Tables 1, 2 and 3).

Patient-level beliefs and medication adherence

Among participants who reported non-adherence, the most common reason was forgetfulness (84.6%), followed by financial issues (62.6%) and the complexity of drug regimens (19.8%). Other reasons included the absence of symptoms (12.1%), negligence (7.7%), medication side effects (4.4%), lack of belief in drug efficacy (3.3%), anger about their condition (1.1%), and miscellaneous factors (2.2%).

Discussion

This study examined adherence to antihypertensive medications and the factors influencing adherence among patients attending a hypertensive clinic in Ghana. The relatively high level of adherence observed in this study suggests that most patients are generally compliant with their antihypertensive medications, which may reflect the effectiveness of ongoing patient education and follow-up

strategies within the clinic. Non-adherence to antihypertensive treatment regimens remains a significant challenge, especially in developing countries, where it is a major contributor to uncontrolled hypertension [11, 33-37]. This adherence rate aligns with similar findings from studies in Ethiopia and Nigeria [13, 36] and is consistent with the estimated global rate of 68.6% [35]. These similarities suggest that our findings may reflect a broader trend across Africa and beyond.

However, our observed adherence rate is lower than that reported in some other regions. Sarkodie et al. documented an 89.2% adherence rate at two district hospitals in the Volta Region of Ghana, and studies in Korea, Taiwan, and Scotland reported adherence levels of 81.7%, 82.7%, and 91.0%, respectively [16, 36, 38, 39]. Conversely, our rate was higher than those reported in other Ghanaian settings, such as the 41.4% adherence at Kintampo Municipal Hospital in the Bono East Region, 7% at Komfo Anokye Teaching Hospital, 47.7% at Korle-Bu Teaching Hospital, and 33.3% in a multicenter study across Ghana and Nigeria [13, 16, 17, 40]. The relatively low adherence rate observed in this study may be influenced by several factors reported by participants. Forgetfulness was the most common reason for non-adherence, followed by financial constraints and the complexity of drug regimens. Other contributing factors included the absence of symptoms, negligence, medication side effects, lack of belief in the effectiveness of drugs, and frustration or anger about their condition. These findings were consistent with those of other studies [17, 35]. These observed differences could be attributed to differences in the sociodemographic characteristics of the population, sample size, study design, and type of tool used in data collection.

Contrary to previous studies [41], educational level did not significantly affect adherence. However, ethnicity and income level were both significantly associated with adherence, aligning with findings from [42]. Notably, non-Akan participants were approximately 3.5 times more likely to adhere than Akans, suggesting cultural or social factors may influence medication behavior. Income also significantly predicted adherence. Interestingly, participants with higher income levels were less likely to adhere to their antihypertensive treatment compared to those with lower income levels, but contrary to previous reports [41, 43]. These findings highlight the importance of tailored interventions, particularly among Akan populations and higher-income groups, and call for policy-level solutions to address disparities and improve adherence to antihypertensive therapy [35, 42–44].

Our study found a positive association between frequent blood pressure monitoring and adherence to antihypertensive medication. Participants who regularly monitored their blood pressure exhibited higher adherence rates. A similar study [45] showed that adherence to antihypertensive medication was significantly improved in people with positive lifestyle changes such as monitoring of blood pressure. Participants who reported regularly monitoring their blood pressure were nearly twice as likely to adhere to medication regimens. Furthermore, those who monitored their blood pressure “once they remembered” were even more likely to adhere, although this finding may reflect self-selection bias among health-conscious individuals. These results align with previous studies suggesting that self-monitoring reinforces disease awareness and accountability, ultimately enhancing adherence [46] .

Coffee consumption showed a weak association with adherence to antihypertensive medication, supporting findings by Samadian et al. [47]. The relationship between coffee intake and medication adherence remains inconclusive in literature. While some studies report a positive association between coffee use and adherence [48], which is consistent with findings in our current study, contrary to our findings, others suggest that no significant link exists between healthier lifestyle behaviors among coffee drinkers [49]. One proposed mechanism is that caffeine may interfere with the pharmacodynamics of certain antihypertensive drugs, potentially reducing their effectiveness [50], or its stimulating effects might contribute to forgetfulness and missed doses [51]. Moreover, caffeine metabolism varies by individual, and the impact may depend on the amount consumed, moderate intake (3–5 cups/day) may have little effect, while excessive intake could be problematic [52]. Although some research highlights caffeine’s potential cognitive benefits, such as protection against dementia [52], its overall impact on adherence, especially in hypertensive populations, remains unclear; therefore, further investigation that includes detailed dietary assessment and objective adherence monitoring is necessary to establish a definitive relationship and inform patient counselling.

Research has consistently shown that individuals with health insurance are more likely to receive preventive care, including regular check-ups and screenings, which facilitate the early (diagnosis and treatment of conditions such as hypertension [53]. Additionally, insured individuals tend to have better adherence to prescribed medication regimens for chronic conditions, including hypertension [53]. While individual experiences may vary, the overall evidence suggests that health insurance plays a crucial role in improving blood pressure control and medication compliance. A study by Ashigbie et al. (2016) found that Ghana’s National Health Insurance Scheme (NHIS) has significantly improved access to essential medicines [54]. This is consistent with reports from [16], which reported that respondents with NHIS adhered to drug regimens than those who paid for their

drugs. In line with this, our study revealed that a substantial proportion of participants (45.0%) obtained their antihypertensive medication through NHIS. However, 82 participants (28.2%) had to purchase their medication entirely out-of-pocket, while 78 participants (26.8%) relied on NHIS but still had to cover part of the cost themselves. This aligns with Ashigbie et al. findings that healthcare facilities across Ghana face low and delayed reimbursement rates, often resulting in stock shortages of medications covered under NHIS [54]. Patients often have to buy medications from private pharmacies when hospital pharmacies lack supplies or NHIS doesn't cover them. This points to the need for NHIS improvements to ensure consistent access. Insured patients show better adherence, highlighting the influence of socioeconomic factors on treatment compliance. Addressing existing disparities through targeted strategies, such as optimizing NHIS reimbursement mechanisms and strengthening medication supply chains, could enhance medication adherence and overall health outcomes for hypertensive patients [53].

Forgetfulness was a common reason for nonadherence to antihypertensive medication. Managing multiple drugs and complex schedules adds to the difficulty, especially for patients with mobility issues or insurance challenges. Tools like reminder apps and pill boxes can help. The study found a weak link between the number of medications and adherence. Asgedom et al. found that patients taking two or more antihypertensive drugs were less likely to adhere to treatment than those on a single medication [55]. While once-daily, single-tablet regimens are easier to follow, they may not be practical for older patients with multiple health issues. The relationship between medication number and adherence is complex, influenced not just by quantity but by the overall complexity of the treatment, side effects, and patient understanding. More research is needed to explore these factors in depth.

The absence of symptoms is a well-documented reason for nonadherence with antihypertensive medications. Hypertension is often called the "silent killer" because it is asymptomatic, especially in the early stages [8]. Since they do not feel unwell, some patients mistakenly believe that they do not need medication or that they can stop taking it if they feel good. This makes the disease condition progress undetected, causing deadly complications of hypertension, such as stroke and kidney failure.

Negligence is also a risk factor for nonadherence. Most hypertensive patients do not realize the threat when dealing with the disease. Thus, accepting the role of patient and treatment is not acceptable to them. This could mostly be because they had either incorrect or no knowledge about their condition [56]. Some patients, despite having adequate knowledge, do not take their treatment seriously because hypertension is often asymptomatic. Without noticeable symptoms, they may underestimate the condition and continue their usual activities without prioritizing treatment. Williams et al. suggested that patients become aware of their disease condition to accept treatment and continue maintaining their health [57]. Medication side effects are frequently identified as major factors influencing medication adherence, particularly for long-term conditions such as hypertension [58]. The number of participants who reported medication side effects as a reason for nonadherence to medication was 4.3%. This is consistent with findings from a study performed by Sarkodie et al. [16].

A lack of belief in antihypertensive medications is also a reason for nonadherence. Belief in the cause of disease and the meaning of illness largely determines if and how patients will take their medications. If patients believe that diseases are of spiritual origin, then they are most likely not to take orthodox medications prescribed by doctors, as they believe that spiritual matters are best addressed spiritually [59]. Anger or hostility toward having hypertension can contribute to poor medication adherence. While a direct cause-effect link is unclear, such negative emotions are often associated with traits like poor social skills and lack of support, which are known to reduce adherence to treatment [60].

Our study found a positive association between frequent blood pressure monitoring and adherence to antihypertensive medication. Participants who reported regularly monitoring their blood pressure were nearly twice as likely to adhere to medication regimens. Furthermore, those who monitored their blood pressure "once they remembered" were even more likely to adhere. This aligns with findings from [16] which reported that patients with higher adherence levels achieved better blood pressure control compared to those with lower adherence rates. A similar study from [45] showed that adherence to antihypertensive medication was significantly improved in people with positive lifestyle changes such as monitoring of blood pressure. although this finding may reflect self-selection bias among health-conscious individuals. These results align with previous studies suggest that self-monitoring reinforces disease awareness and accountability, ultimately enhancing adherence [46].

This study highlights the critical role of knowledge and perception in promoting adherence to antihypertensive therapy. A strong, positive relationship was observed between patients' understanding of hypertension and their medication adherence, consistent with findings in previous research [61-63] and are further supported by evidence that understanding the purpose and mechanism of prescribed drugs helps patients engage actively in their treatment [64]. Participants who were familiar

with their medications and those who correctly understood their dosages were more likely to adhere. These findings emphasize that health literacy is foundational to adherence, as supported by global literature [65, 66]. While knowledge alone is a strong factor, a more comprehensive approach incorporating targeted counseling, behavioral support, and the removal of practical barriers is essential [67, 68]. Empowering patients through consistent education, especially by healthcare providers, enhances adherence and enables better long-term hypertension management [69]. The perception of complications was also influential. Participants, unaware of any hypertension-related complications, were significantly less adherent, suggesting that perceived disease severity may influence medication-taking behavior.

Although Ghana's NHIS reports a service coverage rate of 95%, the Sustainable Development Goals (SDGs) tracker indicated a lower national service coverage index of 47% in 2017, highlighting disparities in access and care quality [60]. There is a pressing need to standardize high-quality treatment across all NHIS-accredited facilities and reduce out-of-pocket expenses [60]. A collaborative effort involving governments, healthcare providers, pharmaceutical companies, and Non-Government Organizations (NGOs) is essential for improving adherence. These stakeholders play a critical role in ensuring drug availability, providing financial assistance, and enhancing patient education.

This study found a significant association between medication availability and adherence, with participants who reported readily available drugs being over four times more likely to adhere. These findings underscore the structural dimension of adherence, where systemic barriers such as stock-outs, high medication costs, and limited pharmacy access hinder continuous treatment, particularly in resource-constrained settings [70, 71]. Similar conclusions were drawn by Sarfo et al., who emphasized that consistent access to antihypertensive medications greatly improves the likelihood of achieving and maintaining optimal blood pressure control [72]. Therefore, enhancing drug availability and affordability is crucial for improving treatment adherence and achieving better health outcomes.

Limitations

This study employed a cross-sectional design, which limits our ability to establish causal relationships between the investigated factors and medication nonadherence. The sample was drawn from a single hospital, limiting the generalizability of the findings to the broader population. The use of convenience sampling may introduce selection bias, as participants who were more readily available or willing to participate may not represent all individuals with hypertension. This could affect the applicability of the results to other settings or populations. Other factors that may affect patient compliance, such as depression, anxiety, and difficulties obtaining primary health care, were not included in this study. Furthermore, participants were predominantly female, Akan, urban residents, and married, which may limit the diversity of perspectives and experiences captured. Data collection relied on self-reported information for certain variables, which may be subject to recall bias. Participants might have had difficulty accurately remembering or reporting past behaviors and experiences, potentially leading to misclassification of exposures and outcomes. In addition, potential confounders such as dietary patterns, physical activity, and social support, which can influence adherence, were not assessed. Laboratory investigations, including serum drug levels to objectively verify adherence, were also not performed due to resource constraints. In this study, medication adherence was assessed using a single self-reported question ("Do you regularly take your medications?"). While this approach provided a simple and practical means of gauging adherence behavior among participants, it may not fully capture the complexity of medication-taking practices, such as timing, dosage, and frequency. This method has been employed in previous studies conducted in similar low-resource settings where the use of standardized adherence assessment tools is not always feasible. Nevertheless, we acknowledge this as a limitation and recommend that future studies utilize validated adherence measurement scales, such as the Morisky Medication Adherence Scale (MMAS) or similar instruments, to obtain a more comprehensive and objective assessment of medication adherence.

Conclusion

Hypertension remains a major public health concern, with medication adherence being vital for effective management. This study found a high adherence rate, consistent with global trends, though influenced by socioeconomic and healthcare system variations. However, Key barriers affecting medication adherence included forgetfulness, financial constraints, complex regimens, and absence of symptoms. Ethnicity, income, and behavioral factors were significantly found to influence adherence. Non-Akan individuals and those with lower income showed better adherence. Regular blood pressure monitoring, coffee consumption, and strong knowledge of medications, including dosage and complication awareness, were critical predictors for medication adherence with a positive association. Enhancing adherence requires a multifaceted strategy involving improved education such as (patient centered education and misconception) sustained medication availability and expanded NHIS coverage to ensure affordability and accessibility of essential drugs. Additionally, integrating

technology-based reminders and counselling interventions can enhance adherence rates. Addressing these challenges through collaborative efforts among healthcare providers, policymakers, and non-governmental organizations will be instrumental in reducing the burden of hypertension and its associated complications.

Abbreviations

BMI	Body Mass Index
BP	Blood Pressure
CCTH	Cape Coast Teaching Hospital
DBP	Diastolic Blood Pressure
FBG	Fasting Blood Glucose
GHS	Ghana Health Service
HDL	High Density Lipoproteins
NHIS	National Health Insurance Scheme
LHIMS	Lightwave Health Information Management System
LDL	Low Density Lipoproteins
MAP	Mean Arterial Pressure
OPD	Outpatient Department
RBG	Random Blood Glucose
SBP	Systolic Blood Pressure
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1.

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Authors' contributions
Conceptualization and study design: OR, Implementation of research: FOA, OR, NET; Participant recruitment and data collection: AAD, FZ, FOA, IOB, Data management and formal analysis: OR, FOA, ROAJ, RSA; Writing – original draft: OR, NET, AAD, FOA, ROAJ, IOB, ETD, NUAS. Final draft: OR, NET, ETD, PN. All the authors read and approved the manuscript in its current form.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval was provided by the Cape Coast Teaching Hospital Ethical Review Committee (CCTHERC) in accordance with the revised Helsinki Declaration of 1964 (revised 2013) on human experiments with the ethical clearance reference number CCTHERC/EC/2023/043. The study posed miminal risk to participants since it relied on noninvasive procedures. There was no cost or compensation to the respondents. The respondents had the opportunity to be educated on what hypertension was and lifestyle modifications to help control hypertension. Voluntary written informed consent was obtained from the participants. The study was conducted in an environment with no form of coercion, and volunteers were adequately informed of the purpose, nature and procedures of the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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