Integrated Blood Pressure Control

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ORIGINAL RESEARCH

Medication Adherence and Blood Pressure Control Among Hypertensive Outpatients Attending a Tertiary Cardiovascular Hospital in Tanzania: A Cross-Sectional Study

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Background: Notwithstanding the availability of effective treatments, asymptomatic nature and the interminable treatment length, adherence to medication remains a substantial challenge among patients with hypertension. Suboptimal adherence to BP-lowering agents is a growing global concern that is associated with the substantial worsening of disease, increased service utilization and health-care cost escalation. This study aimed to explore medication adherence and its associated factors among hypertension outpatients attending a tertiary-level cardiovascular hospital in Tanzania.

Methods: The pill count adherence ratio (PCAR) was used to compute adherence rate. In descriptive analyses, adherence was dichotomized and consumption of less than 80% of the prescribed medications was used to denote poor adherence. Logistic regression analyses was used to determine factors associated with adherence.

Results: A total of 849 outpatients taking antihypertensive drugs for ≥1 month prior to recruitment were randomly enrolled in this study. The mean age was 59.9 years and about two-thirds were females. Overall, a total of 653 (76.9%) participants had good adherence and 367 (43.2%) had their blood pressure controlled. Multivariate logistic regression analysis showed; lack of a health insurance (OR 0.5, 95% CI 0.3–0.7, p<0.01), last BP measurement >1 week (OR 0.6, 95% CI 0.4–0.8, p<0.01), last clinic attendance >1 month (OR 0.4, 95% CI 0.3–0.6, p<0.001), frequent unavailability of drugs (OR 0.6, 95% CI 0.3–0.9, p = 0.03), running out of medication before the next appointment (OR 0.6, 95% CI 0.4–0.9, p = 0.01) and stopping medications when asymptomatic (OR 0.6, 95% CI 0.4–0.8, p<0.001) to be independent associated factors for poor adherence.

Conclusion: A substantial proportion of hypertensive outpatients in this tertiary-level setting had good medication adherence. Nonetheless, observed suboptimal blood pressure control regardless of a fairly satisfactory adherence rate suggests that lifestyle modification plays a central role in hypertension management.

Keywords: medication adherence, nonadherence, drug adherence, hypertension, blood pressure control

Background

Hypertension, which affects over a quarter of the global population, is currently the leading cause of non-communicable diseases (NCDs) and the main contributor to disability adjusted life years (DALYs) worldwide.[1,2] In a span of just 3 decades, the World Health Organization (WHO) African region has witnessed a dramatic upsurge of hypertension prevalence from 9.7% in 1990 to 46% in 2020, making it the most affected WHO region.[2–7] While the last national representative survey conducted in Tanzania found that 26% of the adult population were hypertensive, a rate of nearly 50% reported by a more recent population-based study conducted in the island of Mafia potentially imply a significantly

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higher burden of hypertension in this East African nation.[8,9] So to prevent hypertension-related complications and deaths, optimal control of blood pressure (BP) is paramount.[10–13] Nonetheless, with just 7% of the hypertensive population having controlled BPs in sub=Saharan Africa (SSA), Africans have the worst hypertension control rates and superior hypertension-related complications compared to their Caucasian counterparts.[7,14]

Notwithstanding the availability of effective treatments, asymptomatic nature and the interminable treatment length, adherence to medication remains a substantial challenge among patients with hypertension. Moreover, in spite of numerous advances made in adherence research (ie identification of nonadherence determinants and exploration of impact of interventions to improve adherence), rates of suboptimal adherence have remained more or less the same over the years.[15,16] According to the WHO, over a half of persons with hypertension discontinue their antihypertensives entirely within the first year of diagnosis and at most a half of those staying on medications consume ≥80% of their prescribed regimens.[17] As a consequence approximately three-quarters of patients do not attain optimum BP control thus making poor adherence a prominent cause of uncontrolled hypertension globally.[18] Furthermore, apart from it being the noticeable cause of apparent resistant hypertension, nonadherence is accountable for the substantial worsening of disease, increased service utilization and health-care cost escalation.[19–24] Considering the rapidly growing burden of hypertension in Tanzania, this study aimed to explore medication adherence and its associated factors among hypertension outpatients attending a tertiary-level cardiovascular hospital in Tanzania.

Methodology

Study Design, Recruitment Process, and Definition of Terms

Between April 2021 and October 2021 a hospital-based cross-sectional study was conducted at a tertiary care public teaching hospital (ie Jakaya Kikwete Cardiac Institute [JKCI]) in Dar es Salaam, Tanzania. A simple random sampling method was utilized to recruit consented hypertensive outpatients during their scheduled clinic visit. A structured questionnaire bearing variables pertaining to a study's objective was utilized in this study. Prior to its use in this study, the data collection tool was subjected to evaluation and validation. Informed consent was sought from every participant prior to enrolment. Patients aged ≥18 years on antihypertensive medications for ≥30 days prior to recruitment were eligible for participation in this present study.

Prior to commencement of the study, a list of hypertensive patients with their respective clinic appointments for the entire study duration was obtained from the medical records department. Data on the previously prescribed antihypertensive medications was fetched from the hospital management information system (HMIS). A day prior to their scheduled clinic visit, potential participants were phoned and asked to come with their medication bottles/boxes. Utilizing a pill-count form, number of remaining antihypertensive pills in the bottle/box was recorded upon recruitment. The pill count adherence ratio (PCAR) (ie (pills consumed divide by pills prescribed during the last visit) × 100) was used to compute adherence rate. In descriptive analyses, adherence was dichotomized and consumption of less than 80% of the prescribed medications was used to denote poor adherence.[25,26] This cut off (ie ≥80% consumption) has been shown to achieve BP control and correlate well with cause-specific hospitalization in hypertensive patients.[27–29] Furthermore, following an extensive literature search coupled with its overarching objectives, this study assessed a total of 13 potential barriers to adherence including; cost, side effects, forgetfulness, negligence, unavailability of drugs, pill burden, treatment fatigue, disease fatigue, "healed through prayers" belief, "medications not helpful" belief, unawareness of treatment length, running out of medications, and stopping medications when asymptomatic.

Physical Activity Vital Sign (PAVS)[30] questionnaire was employed in the assessment of physical activity. Reported moderate-vigorous physical activity of 0 min/week, <150 min/week, or ≥150 min/week was used to classify participants as inactive, underactive or active respectively. Body mass index (BMI) cut-off values of <18.5 kg/m^2, 18.5–24.9 kg/m^2, 25.0–29.9 kg/m^2, ≥30.0 kg/m^2 was used to categorize individuals as underweight, normal weight, overweight or obese.[31] Regarding smoking, participants with a negative history of smoking were regarded as never-smokers while use of cigarettes within the last 6 months or self-reported quitting smoking was used to denote current smokers and ex-smokers respectively. Consumption every week of an alcoholic beverage was used to define a drinker. Awareness of risk factors

for hypertension was assessed using an open ended question. Participants were prompted to mention as many risk factors as they know and the correct responses were marked against the predesigned checklist in the questionnaire.

Two BP readings (roughly 2 minutes apart) were taken using an OMRON HEM-7156 digital automated sphygmomanometer and systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg was used to indicate uncontrolled BP.[32,33] A fasting blood glucose (FBG) ≥7 mmol/L, glycated hemoglobin (HbA1c) of ≥6.5% or use of glucose-lowering agents was used to define diabetes while a one touch select plus glucometer was utilized in blood glucose concentration measurements.[34] A 2-dimensional echocardiography (ECHO) was utilized for cardiac assessment with an ejection fraction (EF) ≤40% used to signify systolic heart failure.[35] The Modification of Diet in Renal Disease (MDRD) equation was utilized in the estimation of renal functions and an estimated glomerular filtration rate (eGFR) value of <60 mL/min/1.73 m^2 was used to denote renal dysfunction.[36] Hemoglobin (Hb) concentration of <13.0 g/dL and <12.0 g/dL for males and females respectively was used to diagnose anemia.[37] Low-density lipoprotein (LDL) cut-off levels of 3.5 mmol/L was used to categorize hypercholesterolemia.[38]

Statistical Analysis

STATA v11.0 software was employed in all statistical analyses. Summaries of continuous variables and categorical variables are presented as means (± SD) and frequencies (percentages) respectively. Pearson Chi square and Student's *t*-test techniques were used in comparison of categorical and continuous variables respectively. Logistic regression analyses was used to determine factors associated with adherence. Factors included in our logistic regression model included age, sex, education level, marital status, employment status, residence, health insurance possession status, last clinic attendance, last BP measurement, hospitalization, traditional medicine use, BP control, and potential barriers (ie cost, unavailability of drugs, treatment fatigue, healed belief, running out of drugs, and stopping medications when asymptomatic). Statistically significant variables in the multivariate regression model were assessed following a stepwise and forward inclusion method. The multivariate model was fitted with baseline covariates associated with adherence by bivariate analysis at the <0.05 significance level. Odd ratios (OR) with 95% confidence intervals and p-values are reported. All tests were 2-sided and $p<0.05$ was used to signify a statistical significance.

Results

Characteristics of the Study Participants

Table 1 displays the sociodemographic and clinical characteristics of the 849 enrolled study participants. The mean age was 59.9 and just over a half of all participants were aged above 60 years. Females constituted nearly two-thirds (65.7%) of participants and 60.7% had attained at most primary education. About a half (50.1%) of participants were either jobless or retired, almost two-thirds (64.8%) were living with a partner and nearly three-quarters (74.1%) had health insurance. Roughly 0.3%, were current smokers, 5.9% alcohol consumers, 74.0% were insufficiently active and 80.2% had excess body weight (ie overweight 32.0% and obese 48.2%). Regarding comorbidity history, 14.4% had a history of type 2 diabetes, 16.0% had renal dysfunction, 38.2% had hypercholesterolemia, 11.4% had heart failure, 49.6% had anemia and 11.7% had a history of stroke. With reference to awareness of risk factors for hypertension; excess salt intake was acknowledged by 38.2% of participants, excess fat intake by 67.4%, overweight by 16.8%, physical inactivity by 12.7%, smoking by 3.9%, excess alcohol intake by 10.3% and positive family history by 3.2%; Figure 1.

Pattern of Antihypertensives Prescribed, Adherence and BP Control

About two-thirds of participants (64.3%) had attended a hypertension clinic within one month prior to enrolment in this present study and 2.7% could state the BP control range (ie <140/90 mmHg) correctly. Participants with a within one month outpatient visit displayed superior adherence rates compared to their counterparts whose last visit was over a month ie 83.5% vs 65.0%, $p<0.001$. Over a third (37.8%) of participants had measured their BPs within a week prior to their scheduled clinic visit and overall 51.2% of participants' last BP was taken during their previous clinic visit. Participants who had measured their BPs within a week prior to recruitment displayed higher adherence rates compared to their counterparts ie 83.5% vs 72.9%, $p<0.001$.

Table 1 Sociodemographic and Clinical Characteristics of Study Participants (N = 849)

Characteristic	Frequency (%)
Age	
Mean (SD)	59.9 (11.4)
Age groups	
<45 years	90 (10.6%)
45–60 years	311 (36.6%)
>60 years	448 (52.8%)
Sex	
Male	291 (34.3%)
Female	558 (65.7%)
Education	
No formal	66 (07.8%)
Primary	449 (52.9%)
Secondary	222 (26.1%)
University	112 (13.2%)
Marital status	
Married/Cohabiting	550 (64.8%)
Single/Divorced/Widowed	299 (35.2%)
Occupation	
Jobless	206 (24.3%)
Self-employed	287 (33.8%)
Employed	137 (16.1%)
Retired	219 (25.8%)
Residence	
Dar es Salaam	525 (61.8%)
Upcountry	324 (38.2%)
Health financing	
Exempted by policy	74 (08.7%)
Cost sharing	146 (17.2%)
Insured	629 (74.1%)
Awareness of risk factors for hypertension	
Excess salt	325 (38.2%)
Excess fats	572 (67.4%)
Overweight	143 (16.8%)
Positive family history	27 (03.2%)
Physical inactivity	108 (12.7%)
Smoking	33 (03.9%)
Excessive alcohol intake	87 (10.3%)
Smoking history	
Never	779 (91.8%)
Ex-smoker	67 (07.9%)
Current	3 (0.3%)

(*Continued*)

Table 1 (Continued).

Characteristic	Frequency (%)
Alcohol intake	
Never	535 (63.0%)
Past	264 (31.1%)
Current	50 (05.9%)
Physical activity	
Inactive	222 (26.2%)
Underactive	406 (47.8%)
Active	221 (26.0%)
BMI (Mean, SD)	30.0 (5.8)
BMI category	
Underweight	5 (0.6%)
Normal	163 (19.2%)
Overweight	272 (32.0%)
Obese	409 (48.2%)
Comorbidities	
Diabetes mellitus	122 (14.4%)
Stroke	99 (11.7%)
Renal dysfunction	136 (16.0%)
Heart failure	97 (11.4%)
Anemia	421 (49.6%)
Hypercholesterolemia	324 (38.2%)
Last BP measurement (Mean, SD)	30.7 (37.0%)
≤7 days	321 (37.8%)
>7 days and ≤30 days	376 (44.3%)
>30 days	152 (17.9%)
Last clinic visit*	435 (51.2%)
Last clinic attendance	
≤30 days	546 (64.3%)
>30 days and <90 days	202 (23.8%)
>90 days	101 (11.9%)
Hospitalization (past 6 months)	
Yes	77 (09.1%)
No	772 (90.9%)
Awareness of "BP control" range	
Yes	23 (02.7%)
No	826 (97.3%)
Class of anti-hypertensives prescribed	
ACE inhibitors	38 (04.5%)
ARBs	473 (55.7%)
CCBs	519 (61.1%)
β-blockers	267 (31.5%)
Diuretics	421 (49.6%)
Vasodilators	42 (05.0%)

(*Continued*)

Table 1 (Continued).

Characteristic	Frequency (%)
Traditional medicine use	
Never	743 (87.5%)
Past	52 (06.1%)
Current	54 (06.4%)
Blood pressure range	
<140/90 mmHg	367 (43.2%)
≥140/90 mmHg	482 (56.8%)

Note: *Proportion of participant's whose last BP measurement was during their last clinic visit.

Nearly 10% of participants had a hypertension-related hospitalization within 6 months of recruitment to the study. Participants with a recent history of hospitalization displayed similar adherence rates to their nonhospitalized counterparts, ie 81.8% vs 76.4%, p = 0.3. A total of 106 (12.5%) participants had ever used traditional medicine for treating hypertension and 6.4% were current users. However, there was no difference in adherence between current traditional medicine users and non-users ie 72.2% vs 77.2%, p = 0.4. Individuals with ≤primary school education displayed inferior adherence rates compared to their ≥secondary education counterparts ie 74.6% vs 80.5%, p = 0.04. Moreover, similar adherence rates were observed across age (≤60 vs >60 years) ie 76.8% vs 77.1%, p = 0.9. Likewise, males had similar adherence to females ie 75.6% vs 77.6%, p = 0.5. Nonetheless, participants with health insurance displayed superior adherence rates compared to their uninsured counterparts ie 79.3% vs 70.0%, p<0.01. Overall, a total of 653 (76.9%) participants had consumed at least 80% of their last prescribed drugs (ie good adherence).

Generally, 270 (31.8%) participants were on monotherapy, 304 (35.8%) on a double-combination regimen, 210 (24.7%) were on a triple-combination regimen and 65 (7.6%) were on more than three antihypertensive agents of different classes. Calcium channel blockers (CCBs) [61.1%] were the most prescribed class, followed by angiotensin

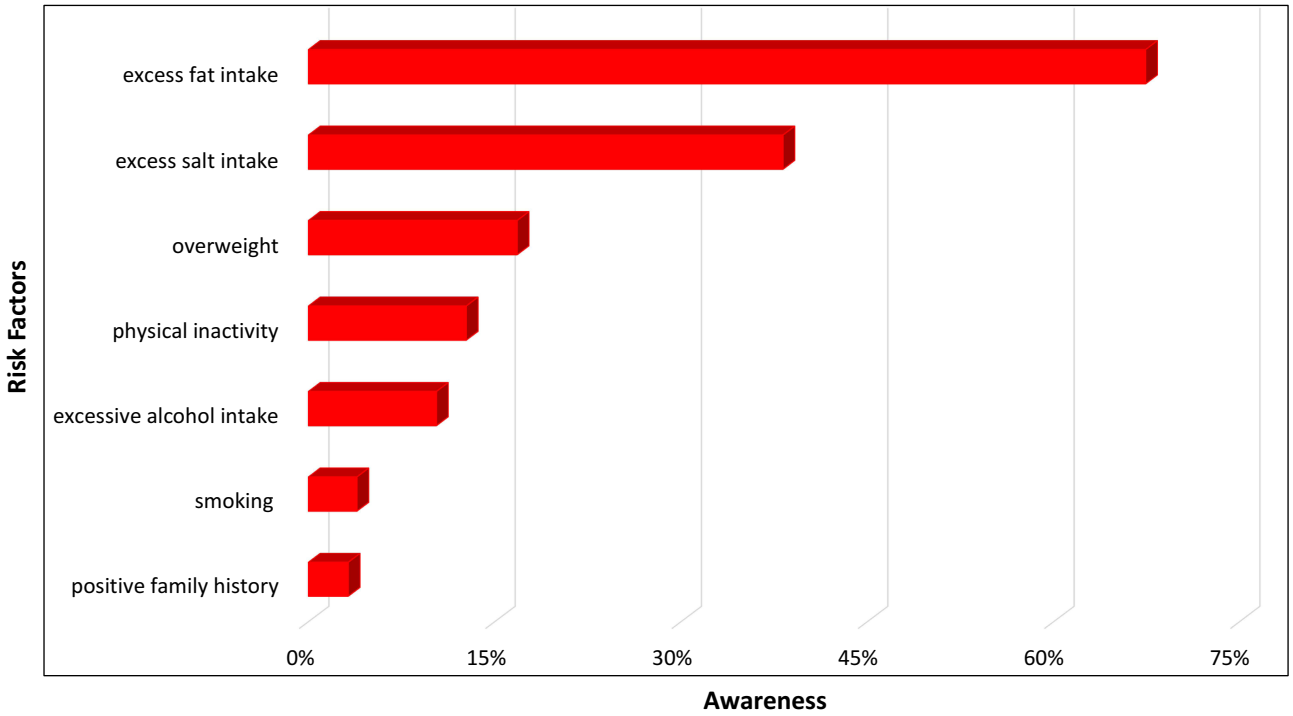

Figure 1 Bar graph displaying participant's awareness of various risk factors for hypertension.

receptor blockers (ARBs) [55.7%], diuretics [49.6%], beta-blockers (β-blocker) [31.5%], vasodilators [5.0%] and angiotensin converting enzyme (ACE) inhibitors [4.5%]. Diuretic plus ARB [91 (10.7%)] was the most frequently prescribed double-combination regimen, followed by ARB plus CCB [66 (7.8%)] and CCB plus diuretic [48 (5.7%)]. With regard to triple-combination regimens, ARB plus CCB plus diuretic [76 (9.0%)] and ARB plus β-blocker plus diuretic [65 (7.7%)] were the commonest.

A total of 367 (43.2%) participants had their BP under control. Age (>60 vs ≤60: 46.2% vs 41.9%, p = 0.2) and sex (male vs females: 41.2% vs 45.7%, p = 0.2) differences displayed similar BP control rates. Individuals with at least secondary school education displayed higher BP control rates compared to their ≤primary education counterparts ie 49.4% vs 40.8%, p = 0.01. Insured participants exhibited superior BP control rate compared to their uninsured equivalents, ie 46.9% vs 36.4%, p<0.01. Furthermore, participants with current use of traditional medicine displayed similar BP control rates compared to non-users ie 51.9% vs 43.7%, p = 0.2. Similarly, participants with good adherence had comparable BP control rates to those with poor adherence ie 45.3% vs 40.3%, p = 0.2.

Barriers to Adherence and Associated Factors

Overall, 96.3% of participants had mentioned at least one barrier to their adherence while nearly three-quarters (73.1%) reported three or more barriers. Disease fatigue (58.3%) was the most reported barrier, followed by "run out of medication before next appointment" (39.9%), forgetfulness (38.3%), "stop medications when symptom-free" (36.6%), and cost of drugs (33.2%). Other barriers included "unaware of treatment length" (29.2%), side effects (18.9%), treatment fatigue (17.7%), "medications not helpful belief" (10.3%), pill burden (9.3%), "healed through prayers belief" (8.8%), unavailability of drugs (8.1%) and negligence (6.7%); Figure 2.

Comparatively (Table 2); the subgroup with poor adherence displayed a significantly higher proportion of participants with the following reported barriers: cost (44.9% vs 29.7%, p<0.001), unavailability of drugs (14.3% vs 6.3%, p<0.001), medication run out (53.1% vs 36.0%, p<0.001), and stopping of drugs when symptom-free (47.4% vs 33.4%, p<0.001). On the other hand, participants with good adherence had a higher proportion of participants with treatment fatigue (19.1% vs 12.8%, p = 0.01) and those who believed they had been healed through prayers (10.3% vs 4.1%, p<0.001).

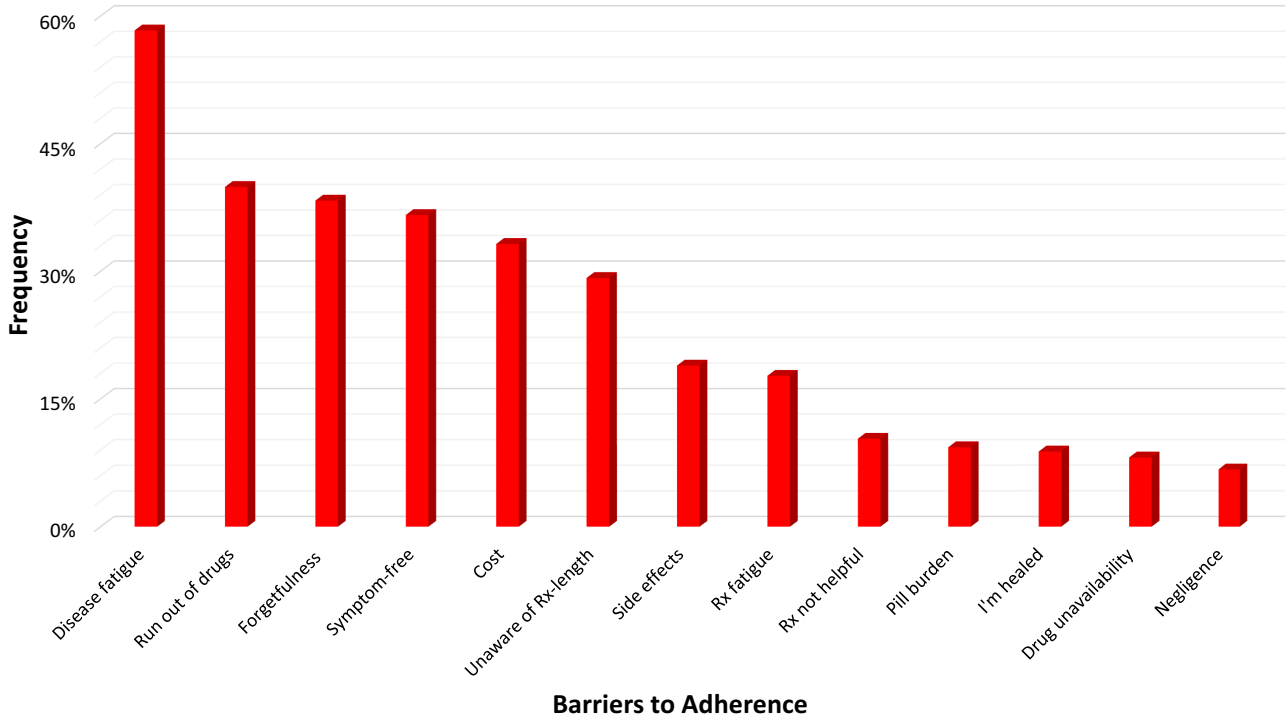

Figure 2 Bar graph displaying frequency and pattern of barriers towards medication adherence.

Table 2 Distribution of Adherence Barriers According to PCAR

Barriers to Adherence	PCAR		p-value
	≥80%	<80%	
Medication cost a barrier Cost not a barrier	194 (29.7%) 459 (70.3%)	88 (44.9%) 108 (55.1%)	<0.001
Side effects No side effects	117 (17.9%) 536 (82.1%)	43 (21.9%) 153 (78.1%)	0.2
Forgetfulness Do not forget	251 (38.4%) 402 (61.6%)	74 (37.8%) 122 (62.2%)	0.9
Negligence No negligence	43 (06.6%) 610 (93.4%)	14 (07.1%) 182 (92.9%)	0.8
Drugs regularly unavailable Drugs regularly available	41 (06.3%) 612 (93.7%)	28 (14.3%) 168 (85.7%)	<0.001
Pill burden Manageable pills	64 (09.8%) 589 (90.2%)	15 (07.7%) 181 (92.3%)	0.3
Treatment fatigue Not tired of treatment	125 (19.1%) 528 (80.9%)	25 (12.8%) 171 (87.2%)	0.01
Disease fatigue I have accepted my illness	383 (58.7%) 270 (41.3%)	112 (57.1%) 84 (42.9%)	0.6
I am healed through prayers My condition is chronic	67 (10.3%) 586 (89.7%)	8 (04.1%) 188 (95.9%)	<0.001
Medications are not helpful Medications are helpful	70 (10.7%) 583 (89.3%)	17 (08.7%) 179 (91.3%)	0.3
Not aware of treatment length Aware of treatment length	193 (29.6%) 460 (70.4%)	55 (28.1%) 141 (71.9%)	0.6
Run out of drugs before next appointment I usually have enough stock until my next visit	235 (36.0%) 418 (64.0%)	104 (53.1%) 92 (46.9%)	<0.001
When I am symptom-free, I stop taking my drugs I take my drugs regardless of how I feel	218 (33.4%) 435 (66.6%)	93 (47.4%) 103 (52.6%)	<0.001

Table 3 shows results of logistic regression analysis for factors associated with adherence. During bivariate analysis in a logistic regression model consisting of eighteen characteristics, ten attributes (ie education, insurance possession, last BP measurement, last clinic attendance, cost of medications, frequent unavailability of drugs, treatment fatigue, healed belief, running out of medication before next appointment and stopping medications when asymptomatic) showed significance. However, after controlling for confounders (multivariate logistic regression), six characteristics, ie lack of a health insurance (OR 0.5, 95% CI 0.3–0.7, p<0.01), last BP measurement >1 week (OR 0.6, 95% CI 0.4–0.8, p<0.01), last clinic attendance >1 month (OR 0.4, 95% CI 0.3–0.6, p<0.001), frequent unavailability of drugs (OR 0.6, 95% CI 0.3–0.9, p = 0.03), running out of medication before next appointment (OR 0.6, 95% CI 0.4–0.9, p = 0.01) and stopping medications when asymptomatic (OR 0.6, 95% CI 0.4–0.8, p<0.001), remained independent associated factors for poor adherence.

Discussion

Despite the remarkable progress in BP measurement methods and the extensive availability of effective pharmacotherapies coupled with the proven prophylactic effects of lifestyle modification, the burden of hypertension continues to rise

Table 3 Associated Factors for Adherence (Logistic Regression Analysis)

Characteristic	Comparative	OR	95% CI	p-value	Adj. OR	95% CI	p-value
Age >60 years	Age ≤60 years	1.0	0.7–1.4	0.9	-	-	-
Male	Female	0.9	0.6–1.2	0.5	-	-	-
≤Primary education	≥Secondary education	0.7	0.5–1.0	0.04	0.9	0.6–1.3	0.6
Single/Divorced/Widowed	Married/Cohabiting	1.1	0.8–1.6	0.5	-	-	-
Jobless/Retired	Self-employed/employed	1.1	0.8–1.4	0.8	-	-	-
Upcountry residence	Dar es Salaam	0.8	0.5–1.0	0.09	-	-	-
Lack of health insurance	Possession of a health insurance	0.6	0.4–0.8	<0.01	0.5	0.3–0.7	<0.01
Last BP measurement >1 week	≤1 week	0.5	0.4–0.8	<0.001	0.6	0.4–0.8	<0.01
Last clinic attendance >1 month	≤1 month	0.4	0.3–0.5	<0.001	0.4	0.3–0.6	<0.001
Hospitalization (past 6mo)	Not hospitalized	1.4	0.8–2.5	0.3	-	-	-
Positive history of traditional medicine	Negative history	0.9	0.6–1.5	0.7	-	-	-
SBP>140 or DBP>90	BP≤140/90	0.8	0.6–1.1	0.2	-	-	-
Cost a barrier	Cost not a barrier	0.5	0.4–0.7	<0.001	0.8	0.6–1.2	0.3
Drugs not always available	Drugs always available	0.4	0.2–0.7	<0.001	0.6	0.3–0.9	0.03
Treatment fatigue	Not tired	0.6	0.4–0.9	0.04	1.1	0.7–1.9	0.6
Believes healed through prayers	I am sick	2.7	1.3–5.7	0.01	2.2	1.0–4.8	0.06
Runs out of drugs before next appointment	Usually have enough stock until next appointment	0.5	0.4–0.7	<0.001	0.6	0.4–0.9	0.01
When I am asymptomatic I stop taking my medications	I take my medications regardless	0.6	0.4–0.8	<0.001	0.6	0.4–0.8	0.001

and its control remains a considerable challenge for health systems across the globe.[39–42] Suboptimal adherence to BP-lowering agents is a growing global concern that constitutes a significant barrier to effective, economical and safe use of medications.[43,44] Impressively, about three-quarters of participants in this present study were categorized as having good adherence to prescribed antihypertensive drugs. Compared with studies that utilized a similar assessment method, variable rates are reported across the literature. In unison to our findings, studies conducted in Pakistan and USA revealed adherence rates between 73.7% and 76.7%.[45–47] However, a couple of studies from Ethiopia, Namibia, Saudi Arabia and Scotland revealed somewhat better adherence rates (84.0% to 87.7%).[48–51] Nonetheless, numerous studies revealed lower rates (37.7–64.0%) of adherence compared to our study.[52–59] Intriguingly, the rates of adherence from this study are remarkably higher than those from an earlier study conducted in the same setting that involved heart failure patients (ie 25.3% had good adherence).[60] Nonetheless, we have observed an extraordinary increase in health insurance possession among patients between the two studies (ie 22.2% vs 74.1%) and we hypothesize this as the main contributor to the adherence discrepancy.[60]

Numerous barriers to adherence among hypertensive patients have been documented in different communities across the globe. Despite the relatively high adherence rate from this study, a large majority of participants (ie 96.3%) acknowledged facing at least one barrier to their adherence. This observation potentially suggests that the current recorded rates could go down at any time if concerted efforts to deal particularly with modifiable barriers are not made in a timely manner. Largely, the

reported barriers from this present study ie disease fatigue, "stop medications when symptom-free", "unawareness of treatment length", treatment fatigue, "medications not helpful belief", and "healed through prayers belief" could be mitigated by improving providers communication (including education and counseling) to patients. Moreover, some barriers ie "run out of medication before next appointment" and unavailability of drugs are health-system related and could be improved by simply refining the appointment system to run parallel with quantity of prescribed drugs as well as strengthening of the inventory management system to almost always ensure a positive stock-balance particularly of commonly prescribed antihypertensives. Additionally, cost remains a huge obstacle in most communities particularly in resource-limited settings like this one. However, in such unprivileged societies (as witnessed in this study) possession of a health insurance is a game changer. In view of this, deliberate yet collaborative efforts to increase its acquisition so as to attain a universal status will be a rewarding endeavor. Nevertheless, the barriers observed in this study have been documented at variable rates by previous research from different settings worldwide.[26,47,48,50,56,59,61–70]

Patients' familiarity with their management plan is a critical success factor to favorable clinical outcomes. Furthermore, patient knowledge of BP goal has been shown to be an independent predictor of BP control.[71] Unfortunately, major deficiencies in communications is characteristic of patient-provider interactions in SSA.[72] Barely 3% of hypertensives in this study were aware of their target BP. Generally, unsatisfactory rates of awareness of target BP is reported in the body of literature, however, our proportion is very low compared to preceding scholarly works (18.2–68.0%).[71,73–79] A quality (clear and comprehensible) and empathic physician-patient communication has been shown to aid adherence to prescribed treatments and to recommended preventive activities.[80–83] For instance, the rates of nonadherence are nearly 20% higher among patients whose healthcare provider communicates poorly versus their counterparts receiving a sound communication.[84] Through collaborative communication and decision making, patients are empowered to understand all essential aspects of their treatment plans which has been correlated with successful reaching of treatment goals. Moreover, as one's understanding correlates with the level of education, it is pivotal that physicians take enough time clarifying the treatment plans and goals particularly to patients with lower levels of education which is a predominant group in the developing world.

Lifestyle measures (ie alcohol reduction, smoking cessation, salt intake reduction, increased physical activity and weight reduction) have been shown to be an effective adjuvant to pharmacotherapy in achieving BP control.[85–90] Likewise, nonadherence to lifestyle modifications is associated with inadequate BP control.[86,91–93] Furthermore, incorporation of lifestyle interventions to antihypertensive medications is associated with a drug step-down.[94,95] Awareness of lifestyle modifiable risks for hypertension was quite low in this present study. Consequently, unhealthy lifestyle behaviors particularly physical inactivity and excess body weight were evident in about three-quarters and four-fifths of participants respectively. Compared to an earlier study in the same setting that involved caretakers of CVD patients, participants of this present study displayed inferior awareness across all risk factors ie excess salt intake 38.2% vs 85.9%, overweight 16.8% vs 90.1%, physical inactivity 12.7% vs 95.6%, smoking 3.9% vs 77.0%, excess alcohol intake 10.3% vs 90.1% and positive family history by 3.2% vs 65.6%.[97] As the awareness assessment used a close-ended method in the previous study while the present study utilized an open-ended way, this might be the possible explanation towards the rate discrepancy. Nevertheless, the unsatisfactory low awareness and practices to lifestyle modification irrespective of the modest medication adherence suggests a potential over-reliance on drugs in lieu of commitment to a healthy lifestyle. These findings however echo Ethiopian, Jordanian, and Iranian studies which revealed that barely a quarter (ie 24.8%, 23.0%, and 27.8% respectively) of its participants were compliant with healthy lifestyle behaviors.[57,96,97] Moreover, quite worrying rates of modifiable lifestyle risks documented by recent community and hospital-based studies from Tanzania calls for a resilient multisectoral approach and urgent evaluation of policies implemented to combat hypertension and other NCDs.[95,98–103]

Improved and sustained BP control is pivotal in reduction of CVD morbidity and mortality. Regardless of the modest adherence rates witnessed in this study, less than a half of participants had achieved BP control. Ranging between 9.4% and 49.9%, a similar pattern (ie less than a half of participants having controlled BPs) is observed from the majority of studies in the body of literature irrespective of the geographical location.[46,76,104–125] However, relatively fewer studies have reported a slightly higher proportion (51.7–63.0%) of participants with desirable BP range.[26,79,126–128] Globally, BP control remains far from adequate regardless of the presence of effective medications and proven healthy lifestyle

changes. Nonetheless, as hypertension control requires a multimethod approach, it is fundamental for healthcare providers to improve not only on the aforementioned communication but should also incorporate assessment of adherence to both pharmacological agents and lifestyle modification in routine clinical practice.

Strengths and Limitations

Numerous strengths can be drawn from this study including; (i) the utilization of a pill count method in assessing adherence mitigated reporting bias, (ii) assessment of various comorbidities that may influence adherence and BP control including chronic kidney disease, heart failure, and diabetes mellitus, (iii) as this study utilized a probability sampling method (ie simple random sampling), this mitigated bias as well as increasing the likelihood of our findings to be generalizable to hypertensive patients attending tertiary care level hospital in SSA and similar resource limited settings. However, we recognize some limitations including; (i) limitation of temporal association exploration due to the cross-sectional nature and (ii) as our assessment of health knowledge and self-care largely based on self-reports, we cannot rule out the possibility of response bias and/or recall bias.

Conclusion

A substantial proportion of hypertensive outpatients in this tertiary-level setting had a good adherence to prescribed antihypertensive medications. Nonetheless, observed suboptimal blood pressure control regardless of a fairly satisfactory adherence rate suggests that lifestyle modification plays a central role in hypertension management. As literally all recognized barriers for adherence in this study are modifiable, this calls for deliberate yet targeted efforts to strengthen the communication of healthcare providers with patients. Furthermore, considering the high prevalence of modifiable lifestyle risk factors (particularly overweight and physical inactivity) and the low awareness of such, it is pivotal for the routine clinical practice and health promotion programs to address lifestyle modification. Lastly, irrespective of the satisfactory adherence rate observed in this study, nonadherence continues to be a significant obstacle in hypertension management thus regular assessment of adherence to medication is fundamental.

Abbreviations

95% CI, 95% Confidence Interval; β-blocker, beta-blocker; ACE inhibitor, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; BMI, body mass index; BP, blood pressure; CCB, calcium channel blocker; CVD, cardiovascular disease; DALYs, disability-adjusted life years; DBP, diastolic blood pressure; ECHO, echocardiography; EF, ejection fraction; eGFR, estimated glomerular filtration rate; FBG, fasting blood glucose; Hb, hemoglobin; $HbA1_c$, glycated hemoglobin; HMIS, health management information system; JKCI, Jakaya Kikwete Cardiac Institute; LDL, low-density lipoprotein; MDRD, Modification of Diet in Renal Disease; NCDs, non-communicable diseases; OR, odds ratio; PAVS, physical activity vital sign; PCAR, pill count adherence ratio; SSA, sub-Saharan Africa; SBP, systolic blood pressure; SD, standard deviation; USA, United States of America; WHO, World Health Organization.

Data Sharing Statement

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

Ethics Approval and Consent to Participate

Participants gave written informed consent to participate in the study. The study protocol was approved by the local ethics committees (Jakaya Kikwete Cardiac Institute) and was conducted in accordance with the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no conflicts of interest in relation to this work.

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