ORIGINAL RESEARCH

Blood pressure control status and associated factors among adult hypertensive patients on outpatient follow-up at University of Gondar Referral Hospital, northwest Ethiopia: a retrospective follow-up study

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Background: Large segments of the hypertensive population in the world are either untreated or inadequately treated. The incidence of heart failure and mortality from cardiovascular complications of hypertension is high among patients with uncontrolled blood pressure (BP). But BP control status of hypertensive patients has not been investigated in the study area. The study aimed to assess BP control status and determinant factors among adult hypertensive patients on antihypertensive medication attending outpatient follow-up at University of Gondar Referral Hospital, northwest Ethiopia.

Methods: An institution-based retrospective follow-up study was conducted from September 2015 to April 2016. Data were collected using a structured and pretested questionnaire adopted from the World Health Organization STEPwise approach. BP records of 6 months were used, and patients were classified as having controlled BP if their BP readings were <140/90 mmHg for all adults ≥18 years of age and <150/90 mmHg for adults aged ≥60 years. A generalized estimating equation was fitted, and the odds ratio with a 95% confidence level was used to determine the effect of covariates on BP control status.

Results: Among 395 participants, 50.4% (95% CI: 45–55) of them controlled their BP in the last 6 months of the survey. Physical activity (adjusted odds ratio [AOR]=1.95, 95% CI: 1.41–2.68), duration on antihypertensive drugs of 2–4 years (AOR=1.70, 95% CI: 1.13–2.56) and 5 years or more (AOR=1.96, 95% CI: 1.32–2.92), and high adherence (AOR=2.18, 95% CI: 1.14–4.15) to antihypertensive drugs were positively associated with BP control, while salt intake (AOR=0.67, 95% CI: 0.49–0.93), overweight (AOR=0.50, 95% CI: 0.36–0.68), and obesity (AOR=0.56, 95% CI: 0.36–0.87) were inversely associated with BP control.

Conclusion: In this study, only half of the hypertensive patients controlled their BP. Thus, health care providers need to be made aware about the importance of counseling hypertensive patients on drug adherence, moderate physical activity, and salt restriction to improve BP control.

Keywords: blood pressure control, associated factors, adults, Gondar

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Introduction

Hypertension (HTN) is a condition where systolic blood pressure (SBP) is ≥140 mmHg or diastolic blood pressure (DBP) is ≥90 mmHg.[1] HTN disproportionately affects populations in low- and middle-income countries where health systems are weak. As

it rarely causes symptoms in the early stages, many people go undiagnosed. Those who are diagnosed may not have access to treatment and may not be able to successfully control their illness over the long-term. Significant health and economic gains are attached to early detection, adequate treatment, and good control of HTN.[2]

The global prevalence of raised BP in adults aged 18 years and above was around 22% in 2014.[3] In Sub-Saharan Africa, an estimated 74.7 million individuals are hypertensive, and by the year 2025, the number of hypertensive individuals is projected to increase by 68% to 125.5 million individuals.[4]

HTN doubles the risk of cardiovascular diseases, such as coronary heart diseases, congestive heart failure, stroke, renal failure, and peripheral arterial diseases.[1] Globally, cardiovascular disease accounts for ~17 million deaths a year, nearly one-third of the total deaths. Of these, complications of HTN account for 9.4 million deaths and 7% of the disease burden worldwide every year. HTN is responsible for at least 45% of the deaths due to heart disease and 51% of deaths due to stroke. There is strong scientific evidence on the health benefits of lowering BP through behavioral and pharmacological interventions.[5]

The incidence of heart failure and mortality from cardiovascular complications of HTN is high among patients with uncontrolled BP.[6] In some age groups, the risk of cardiovascular disease doubles for each increase of 20 mmHg in SBP and 10 mmHg in DBP starting from 115/75 mmHg. Treating SBP and DBP until they are less than 140/90 mmHg is associated with a reduction in cardiovascular complications.[7]

The control of high BP is critical in managing hypertensive patients. Although antihypertensive therapy clearly reduces the risks of cardiovascular and renal diseases, large segments of the hypertensive people are either untreated or inadequately treated.[1] Worldwide, the detection, treatment, and control of HTN are inadequate.[3]

According to the World Health Organization (WHO), approximately one billion persons are living with uncontrolled HTN worldwide.[5] Many studies in different parts of the world show that uncontrolled BP is a common phenomenon among hypertensive patients on treatment.[8–11] Thus, BP was controlled for only less than 50% of the hypertensive patients in Japan,[12] 31.7% in Turkey,[13] and 48.3% in Malaysia.[14] Controlling BP is a difficult experience in Africa too; BP control was accomplished for only 47.7% of the hypertensive patients on follow-up in Tanzania,[15] 35.9% in Uganda,[16] 32.8% in Zimbabwe,[17] 33.4% in Kenya,[18] and 40.1% in Addis Ababa, Ethiopia.[9]

Many socioeconomic, behavioral, and clinical factors affect BP control. Thus, BP is less likely to be controlled among unmarried,[19] male,[20] elderly,[18] less educated,[14] low-income,[17] rural,[9] and unemployed[17] patients. Smoking,[13,17] salt addition habit in meal,[9] and alcohol drinking[17] are associated with poor BP control, whereas vegetable consumption habit[21] and moderate physical activity[22,23] are important behaviors to control BP. Having other comorbidities, like diabetes mellitus (DM) or renal diseases,[12–14] low adherence to antihypertensive treatments,[9,15,20,24] obesity/overweight,[13,15,17] being on multidrug regimen,[14,18,20] and lack of information on complications of HTN are also other factors associated with poor BP control.

HTN has become an important chronic noncommunicable disease with increasing trends in developing countries, and uncontrolled BP will result in life-threatening complications. So, knowing the BP control status of hypertensive patients is very important for policy makers and clinicians responsible for designing appropriate strategies for a better management of hypertensive patients. Therefore, this study aimed to assess BP control status and associated factors among adult hypertensive patients on outpatient follow-up at University of Gondar Referral Hospital (UOGRH), northwest Ethiopia, 2016.

Methods
Study setting and design
A 6-month institution-based retrospective follow-up study was conducted from September 2015 to April 2016 at UOGRH Chronic Illness Clinic. UOGRH is a teaching hospital located in Gondar town, North Gondar Administrative Zone, Amhara National Regional State, 727 km from Addis Ababa, the capital of Ethiopia. UOGRH provides service for about more than five million people in North Gondar Zone and the neighboring zones, West Gojjam and south Tigray.

Sample size and sampling procedure
All adult hypertensive patients who were on outpatient follow-up for at least 6 months and had at least one documented BP measurement result were eligible for the study. Then, all 403 patients who came for follow-up during the data collection period were included in the study.

Data collection instrument and procedure
A structured interviewer-administered questionnaire adopted from the WHO STEPwise approach for chronic disease risk

factor surveillance[25] was used to collect data. The questionnaire was first prepared in English and translated into the local language (Amharic) and finally back to English to maintain consistency. A pretest was conducted on 10% of the sample size out of the study area before the actual data collection. Data collectors and supervisors were trained for 2 days. Two health officer supervisors and three graduate nurses data collectors were recruited for data collection. The process was closely monitored by the principal investigator and supervisors throughout the data collection period. Filled copies were checked daily for completeness of information, and problems were immediately communicated to data collectors.

Assessment of BP control status
BP recordings in the charts of adult hypertensive patients for the last 6 months were reviewed. The last BP was measured by the data collectors using a standard mercury sphygmomanometer BP cuff with the appropriate cuff size that covered two-thirds of the upper arm, while the patient was in a sitting position, had rested for at least 5 minutes, and consumed no cigarettes or caffeine 30 minutes before the measurement. Two consecutive measurements were taken in a minimum interval of 5 minutes, and the mean was recorded. Patients were classified as having controlled BP at each visit with BP readings <140/90 mmHg for all adults ≥18 years old, and <150/90 for adults aged ≥60 years.[26] Then, the BP recordings at each visit were used as dependent variable, but the prevalence of controlled BP was determined by the average BP recordings across the 6 months.

Assessment of adherence to antihypertensive treatment
Adherence to antihypertensive drugs was measured by the four-item Morisky–Green–Levine Scale, which measures both deliberate and unintended adherence grounded on forgetfulness, carelessness, stopping medication when feeling better, and stopping medication when feeling worse. The response categories were either "yes" or "no" for each item. On the whole, 0 point was allocated to a "yes" response and 1 point to a "no" response. The total score ranged from 0 (nonadherent) to 4 (adherent). Then patients were categorized as having high (score=4), medium (score=2–3), and low adherence (score ≤1).

Assessment of physical activity and other behavioral factors
Work or sports that involves moderate-intensity activity that causes small increases in breathing or heart rate, such as brisk walking, carrying light loads, cycling, swimming, volley ball, dancing, gardening, and house working for at least 10 minutes continuously per day, was considered as moderate physical activities.

A participant who smoked at least one cigarette per day at the time of the study was considered as smoker. Male patients who drank more than 2 units of alcohol/day and female patients who drank more than 1 unit of alcohol/day were considered as alcohol consumer.

Fruit and vegetable eating habits of patients were assessed and categorized by dividing the number of days they ate per week into three groups: those who ate for less than 1 day/week (none), 1–3 days/week, and 4–7 days/week.

Assessment of wealth index and knowledge
Household wealth index was determined using Principal Component Analysis (PCA) by considering household assets, such as quantity of cereal products, house, livestock, and agricultural land ownership.[27] First, variables were coded between 0 and 1; then variables were entered and analyzed using PCA, and those variables with a communality value of greater than 0.5 were used to produce factor scores. Finally, factor scores were summed and ranked into "poor", "medium", and "rich" categories. Knowledge about HTN and its complications was assessed using eight-item questions; also, PCA was used to rank patients knowledge into "poor", "medium", and "good".

Body mass index (BMI) and waist circumference (WC) measurements
Weight was measured with participants standing bare foot, wearing light clothing, and was recorded to the nearest 0.1 kg. Height was measured with participants standing upright with the head in Frankfort plane and was recorded to the nearest 0.5 cm. Then, BMI was calculated by dividing weight in kg to height in m^2, and patients were categorized into underweight (BMI <18.5), normal (BMI 18.5–24.9), overweight (BMI 25–29.9), and obese (BMI ≥30).[28]

WC was measured with the subject in a standing position using a nonelastic plastic tape midway between the lower rib margin and the iliac crest to the nearest 1 mm. One layer of clothing was accepted. Based on WC measurements, patients were classified into three health risk categories in accordance with cutoffs recommended by WHO: low risk (men, WC=93.9 cm or less; women, WC=79.9 cm or less); increased risk (men, WC=94.0–101.9 cm; women, WC=80.0–87.9 cm); and high risk (men, WC=102.0 cm or more; women, WC=88.0 cm or more).[29]

Data processing and analysis

After checking for consistency and completeness, the collected data were entered into EPI-INFO version 3.5.3 and then exported to STATA 12 for analysis. Descriptive and summary statistics were carried out. The generalized estimating equation was fitted with logit link function and binomial family and working correlation structures (independent, exchangeable, unstructured, and autoregressive) were compared for the smallest standard error difference of robust and model-based standard error. Then, the exchangeable correlation structure showed the smallest standard error difference, and was selected for this study to handle the within correlation.

Both crude odds ratio and adjusted odds ratio (AOR) with the corresponding 95% CI were calculated to determine the strength of association between dependent and independent variables. Variables with a p-value ≤0.2 in the bivariable analysis were fitted into the multivariable analysis and variables with a p-value of <0.05 were considered as statistically significant.

Ethical approval and consent to participate

Ethical clearance was obtained from the Institute of Public Health Ethical Review Board, University of Gondar (Ref. No. IPH/2880/2016). Permission letter was obtained from the Hospital's clinical director and Department of Internal Medicine to conduct the study. Informed verbal consent was obtained from the respondents, and Institute of Public Health Ethical Review Board, University of Gondar, approved the verbal consent process. The right of participants to withdraw from the study at any time was secured. Personal Identifying information was not recorded on the questionnaire, and all information obtained by face-to-face interview as well as from the patients chart was kept confidential.

Results

A total of 403 patients were included in the study of whom 395 responded, a response rate of 98%.

Sociodemographic characteristics of respondents

Of the 395 participants, 244 (61.8%) were females, and the median age of the respondents was 57 years with an IQR of 16 years. Three hundred sixty (91.1%) of the respondents were from Amhara ethnic group and 361 (91.4%) were orthodox

Table 1 Sociodemographic characteristics of adult hypertensive patients on outpatient follow-up at UOGRH, Gondar, northwest Ethiopia, 2016 (n=395)

Variables	Frequency (n)	Percent
Sex		
Male	151	38.2
Female	244	61.8
Marital status		
Single	18	4.6
Married	242	61.3
Divorced	34	8.6
Widowed	101	25.6
Religion		
Orthodox	361	91.4
Muslim	32	8.1
Protestant	2	0.5
Ethnicity		
Amhara	360	91.1
Kimant	21	5.3
Tigre	14	3.5
Residence		
Rural	80	20.5
Urban	315	79.7
Educational status		
No formal education	179	45.3
Elementary	111	28.1
Secondary and above	105	26.6
Occupation		
Farmer	33	8.4
Government employee	57	14.4
House wife	193	48.9
Merchant	18	4.6
Private employment	47	11.9
Retired	47	11.9
Wealth index		
Poor	132	33.4
Medium	121	30.6
Rich	142	46

Abbreviation: UOGRH, University of Gondar Referral Hospital.

Christians. Out of the total respondents, 242 (61.3%) were married, 179 (45.3%) had no formal education, 315 (79.7%) were urban dwellers, and 142 (46%) lay in the rich class wealth index (Table 1).

Behavioral/lifestyle characteristics of respondents

Out of the 395 participants, only three (0.8%) were current smokers and nine (2.3%) were drinking alcohol at the moment. The majority, 226 (57.2%), of the respondents did not eat fruit and 219 (55.4%) ate vegetables 1–3 days/week. Slightly over half (51.4%) of the participants had moderate physical activity on most days of the week. Two hundred

Table 2 Behavioral characteristics of adult hypertensive patients on outpatient follow-up at UOGRH, Gondar, northwest Ethiopia, 2016 (n=395)

Variables	Blood pressure control status		Chi-square (X^2)	*p*-value
	Controlled	Uncontrolled		
Smoking status				
Yes	1	2	0.351	0.553
No	198	194		
Current alcohol consumption				
Yes	2	7	2.921	0.087
No	197	189		
Physical activity				
None	46	91	25.660	<0.001
1–3 days/week	28	27		
4–7 days/week	125	78		
Vegetable eating habit				
None	56	102	23.814	<0.001
1–3 days/week	131	88		
4–7 days/week	12	6		
Fruit eating habit				
None	115	111	4.578	0.101
1–3 days/week	72	81		
4–7 days/week	12	4		
Type of oil used				
Vegetable oil	116	117	0.080	0.777
Sesame/nug oil	83	79		
Salt intake				
Yes	45	64	4.982	0.026
No	54	132		

Abbreviation: UOGRH, University of Gondar Referral Hospital.

thirty-three (59%) of the respondents were using vegetable oil for their usual meal preparation, and 109 (27.6%) used additional salt in their meals (Table 2).

Clinical characteristics of respondents

Of the total participants, 187 (47.3%) were in the normal BMI range, followed by 129 (32.7%) in the overweight range, and 52 (13.2%) in the obese range. Seventy-four (18.7%) of the participants had a family history of HTN, while 107 (27.1%) had DM and 81 (20.5%) had other complications (cardiac diseases 8.9%, chronic kidney diseases 7.1%, asthma 4.3%, and others 2.6%). Slightly over half (50.6%) of the respondents were on a single antihypertensive drug, whereas the majority (68.9%) were highly adherent to their treatment, and 180 (45.6%) of the participants were on antihypertensive treatment for 5 and more years (Table 3).

Proportion of controlled BP

The participants were followed up for an average of 5.8 visits, with a minimum of 3 and a maximum of 6 visits. The

mean SBP and DBP readings were 138.38 (±14.06 SD) and 80.73 (±6.26 SD) mmHg, respectively. The overall proportion of controlled BP in the last 6 months was 50.4% (95% CI: 45–55). In the first visit, the BP of 221 (55.9%) patients was uncontrolled, and in the sixth visit, the BP of 51.4% patients was controlled. BP control was relatively low at the first visit, and gradually increased during the consecutive follow-ups (Figure 1).

Determinant factors of BP control

The generalized estimating equation result showed that moderate physical activity on most days of the week, vegetable consumption habit, duration on antihypertensive treatment, and adherence to antihypertensive drugs were positively associated with controlled BP, whereas salt use and BMI were negatively associated. But factors like age, sex, educational status, wealth index, number of antihypertensive drugs, and presence of comorbidities were not significantly associated with BP control in this study.

Patients who had physical activity on most days of the week were almost two times (AOR=1.95, 95% CI:

Table 3 Clinical characteristics of adult hypertensive patients on outpatient follow-up at UOGRH, Gondar, northwest Ethiopia, 2016 (n=395)

Variables	Blood pressure control status		Chi-square (X^2)	p-value
	Controlled	Uncontrolled		
Family history of HTN				
Yes	40	34	0.492	0.483
No	159	162		
Knowledge about HTN				
Good	62	62	0.013	0.993
Medium	72	70		
Poor	65	64		
Diabetes mellitus				
Yes	46	61	3.205	0.073
No	153	135		
Other chronic comorbidities				
Yes	39	42	0.203	0.652
No	160	154		
Body mass index				
Underweight	17	10	8.645	0.034
Normal	103	84		
Overweight	52	77		
Obese	27	25		
Waist circumference				
Low risk	44	66	6.610	0.037
Increased risk	59	48		
High risk	96	82		
Adherence				
Low	4	19	25.381	<0.001
Medium	36	64		
High	159	113		
Number of anti-hypertensives taken				
One	103	97	0.206	0.902
Two	91	94		
Three	5	5		
Duration on anti-hypertensives				
≤2 years	24	49	11.482	0.003
2–4 years	74	68		
≥5 years	101	79		

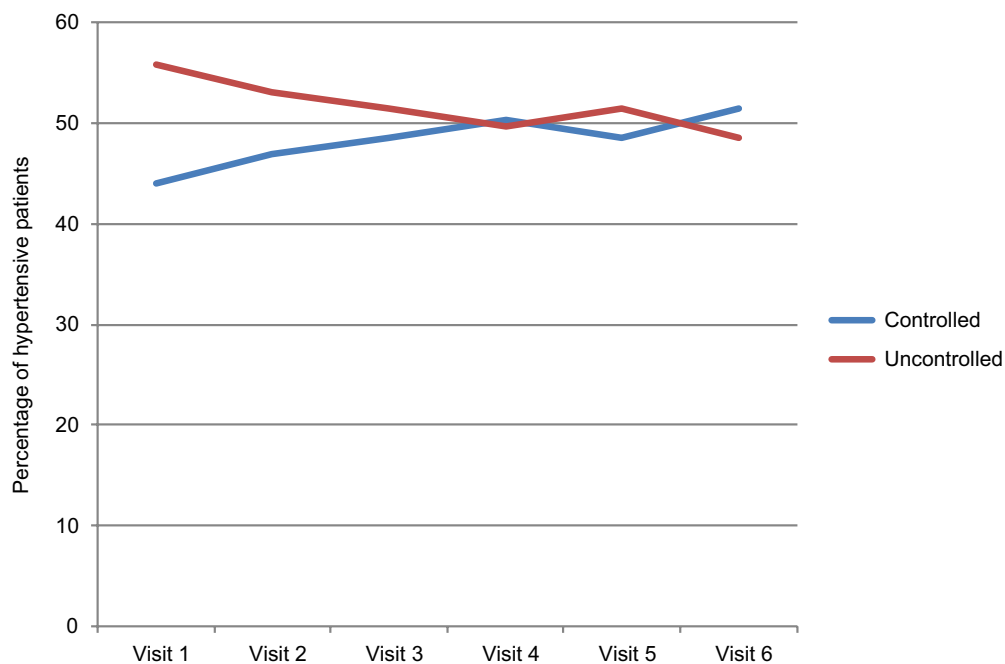**Abbreviations:** UOGRH, University of Gondar Referral Hospital; HTN, hypertension.

1.41–2.68) as likely to have controlled BP compared to patients with no physical activity. Patients who consumed vegetables for 1–3 days/week were two times (AOR=2.24, 95% CI: 1.65–3.06) as likely to have controlled BP compared to patients who did not consume vegetables. Similarly, patients who consumed vegetables for 4–7 days/week were also two times (AOR=2.36, 95% CI: 1.17–4.75) as likely to have controlled BP compared to their counterparts.

The odds of BP control decreased by 33% for hypertensive patients who added salt to their food (AOR=0.67, 95% CI: 0.49–0.93) compared to those who used no salt. At the same time, the odds of BP control decreased by 50% for overweight patients (AOR=0.50, 95% CI: 0.36–0.68) and

44% for obese patients (AOR=0.56, 95% CI: 0.36–0.87) compared to normal or underweight patients.

The odds of BP control were 1.70 times (AOR=1.70, 95% CI: 1.13–2.56) higher for patients who stayed on antihypertensive treatment for 2–4 years and 2 times (AOR=1.96, 95% CI: 1.32–2.92) higher for those who stayed for 5 years or more compared to patients with less than 2 years of stay on treatment.

Adherence to antihypertensive drugs was another important variable that showed a significant association with BP control status. Patients who had high adherence to their antihypertensive drugs were two times (AOR=2.18, 95% CI: 1.14–4.15) as likely to have controlled BP as compared to low adherent patients (Table 4).

Figure 1 Blood pressure control status of hypertensive patients at each visit in UOGRH, 2016.
Abbreviation: UOGRH, University of Gondar Referral Hospital.

Discussion

This study revealed that 50.4% of hypertensive patients on outpatient follow-up controlled their BP over the last 6 months. This finding was higher than those of studies conducted in Turkey (31.7%),[13] Malaysia (48.3%),[14] Tanzania (47.7%),[15] Zimbabwe (32.8%),[17] Kenya (33.4%),[18] Uganda (35.9),[16] and similar study in Addis Ababa, Ethiopia (40.1%).[9] This difference is probably due to a change in the criteria used to classify hypertensive patients as having uncontrolled and controlled BP. Most of the literatures used JNC7 (which was used as a cutoff point >140/90 for nondiabetic patients and >130/80 for diabetic patients to say uncontrolled BP), and the current study was conducted by using the JNC8 guideline.

On the other hand, the result of this study was lower than those of studies done in Sudan (64%),[30] Pakistan (72.3%),[31] and this may be attributed to the difference in the study population and the study design.

This study revealed that patients who did moderate physical activity had a greater chance of having controlled BP. This finding is supported by those of studies conducted in People's Republic of China,[8] Canada,[22] the US,[32] and Ethiopia.[9] This may be due to the fact that regular physical activity makes the heart stronger and can pump more blood with less effort. If the heart works less to pump, the force on the arteries decreases, thus lowering BP. Exercise also has

an effect on the reduction of systemic vascular resistance, plasma norepinephrine, and renin activities.[33]

Eating vegetables was found to be a significant factor for BP control among hypertensive patients. This finding was supported by studies conducted in Chile[21] and People's Republic of China.[34] This is due to the fact that vegetables are low in cholesterol and saturated fat and high in dietary fiber, potassium, calcium, and magnesium, which result in BP reduction.

Using salt for meal preparation was inversely associated with BP control in the current study. Hence, there was a 33% reduction in the chance of BP control among patients who used salt as compared to patients who did not. The result is consistent with those of other studies conducted in People's Republic of China,[8] Zimbabwe,[17] and Addis Ababa, Ethiopia.[9] This is due to the fact that salt disrupts the natural sodium balance in the body, causing fluid retention that increases the pressure exerted by the blood against blood vessel walls.

This study revealed that overweight and obese patients have a less chance of controlled BP. Thus, the likelihood of BP control decreased by 50% for overweight patients and 44% for obese patients as compared to normal/underweight patients. Similar findings were reported by studies conducted in People's Republic of China,[8] Iran,[11] Spain,[35] Zimbabwe,[17] Tanzania,[15] Sudan,[30] and Ethiopia.[9] This may be due to obesity inducing a state of chronic volume overload as a result of

Table 4 Determinant factors of BP control status among adult hypertensive patients on outpatient follow-up at UOGRH, Gondar, northwest Ethiopia, 2016 (n=395)

Variables	BP control status[a]		Crude OR (95% CI)	AOR (95% CI)
	Controlled	Uncontrolled		
Age	–	–	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)
Sex				
Male	66	83	1	1
Female	133	111	1.41 (1.06, 1.86)*	1.31 (0.81, 2.11)
Education				
No formal education	91	88	1	1
Elementary	54	57	0.74 (0.53, 1.03)	0.79 (0.55, 1.14)
Secondary and above	54	47	0.63 (0.45, 0.87)	0.67 (0.41, 1.08)
Occupation				
Housewife	101	92	1	1
Farmer	12	21	0.62 (0.37, 1.04)*	0.82 (0.42, 1.63)
Government employed	35	22	0.65 (0.43, 0.98)*	0.84 (0.46, 1.54)
Merchant	7	11	0.47 (0.23, 0.94)	0.68 (0.32, 1.46)
Private employed	21	26	0.73 (0.47, 1.13)	1.22 (0.67, 2.20)
Retired	23	24	0.91 (0.59, 1.41)	1.18 (0.59, 2.06)
Wealth index				
Poor	69	63	1	1
Medium	66	55	0.91 (0.65, 1.28)	0.83 (0.59, 1.17)
Rich	64	78	0.72 (0.52, 0.99)	0.79 (0.57, 1.11)
Fruit eating habit				
None	115	111	1	1
1–3 days/week	72	81	0.76 (0.57, 1.00)	0.74 (0.54, 1.01)
4–7 days/week	12	4	1.19 (0.59, 2.40)	1.21 (0.60, 2.44)
Vegetable eating habit				
None	56	102	1	1
1–3 days/week	131	88	1.85 (1.39, 2.46)**	**2.24 (1.65, 3.06)**
4–7 days/week	12	6	1.90 (1.14, 3.70)	**2.36 (1.17, 4.75)***
Current alcohol consumption				
Yes	2	7	0.31 (0.10, 0.92)*	0.59 (0.20, 1.74)
No	197	189	1	1
Physical activity				
None	46	91	1	1
1–3 days/week	28	27	1.27 (0.83, 1.96)	1.50 (0.96, 2.33)
4–7 days/week	125	78	1.70 (1.26, 2.30)**	**1.95 (1.41, 2.68)**
Salt intake				
Yes	45	64	0.65 (0.48, 0.88)*	**0.67 (0.49, 0.93)***
No	154	132	1	1
Body mass index				
Normal/underweight	120	94	1	1
Overweight	52	77	0.59 (0.43, 0.80)**	**0.50 (0.36, 0.68)**
Obese	27	25	0.66 (0.43, 1.00)*	**0.56 (0.36 0.87)***
Duration on treatment				
<2 years	24	49	1	1
2–4 years	74	68	1.97 (1.32, 2.95)**	**1.70 (1.13, 2.56)***
≥5 years	101	79	2.22 (1.50, 3.27)**	**1.96 (1.32, 2.92)**
DM				
Yes	46	61	1	1
No	153	135	1.30 (0.95, 1.77)	1.13 (0.82, 1.55)
Adherence				
Low	4	19	1`	1
Medium	36	64	1.55 (0.79, 3.08)	1.33 (0.67, 2.62)
High	159	113	2.99 (1.57, 5.72)**	**2.18 (1.14, 4.15)**

Notes: Significant variables are shown in bold. *Significant at $p<0.05$, **Significant at $p≤0.001$. [a]Blood control status of hypertensive patients on follow-up by taking the average BP over the last 6 months. When OR or AOR value =1, it indicates that is the reference.
Abbreviations: BP, blood pressure; UOGRH, University of Gondar Referral Hospital; OR, odds ratio; AOR, adjusted odds ratio; DM, diabetes mellitus.

increased requirements to circulate blood through large and relatively low resistance adipose tissue.[36]

Coming to duration on antihypertensive treatment, patients with long duration on treatment have better BP control. Though this result is inconsistent with the finding of a study conducted in Addis Ababa, Ethiopia,[9] it is supported by a study in Nigeria.[10] The possible reason for this finding may be an increase in awareness and adherence to antihypertensive treatment as the patient stays on treatment for longer years.

Adherence, as measured by Morisky–Green–Levine Scale, has shown a significant association with controlled BP. According to this study, patients who are highly adherent to their antihypertensive treatments have a greater chance of controlled BP compared to low adherent patients. Many studies, like those conducted in Nigeria,[10] Zimbabwe,[17] Tanzania,[15] and Addis Ababa, Ethiopia,[9] support this finding.

The findings of this study could be used by physicians who care for hypertensive patients in Ethiopia for an evidence-based management of hypertensive patients. They can also serve as a baseline information for public health policy makers in Ethiopia as well as Sub-Saharan Africa for designing guidelines for better BP control among hypertensive patients, thereby reducing HTN-related morbidity and mortality.

Limitations of the study

Information on lifestyle-related variables and drug adherence were collected by interview, and this may lead to recall bias. Social desirability bias may also occur during collecting some covariates (alcohol, smoking) by the interview technique. These may underestimate the effect of these variables on the dependent variable (biasing the measure of association towards the null). There were some potentially time varying covariates (eg, BMI, physical activity) that were taken at the last visit as we did not have the data during the middle visits. In this study, the prevalence of the outcome (controlled BP) is 50%, and the odds ratio may overestimate the risk in measuring the association.

Conclusion

A significant proportion of the hypertensive people had uncontrolled BP. Lifestyle modifications, like doing physical activity, eating vegetables, and avoiding salt addition on meals, were found as effective nonpharmacologic means of BP control. Duration on antihypertensive treatment and adherence to antihypertensive drugs were positively associated with controlled BP, whereas BMI was inversely

associated with controlled BP. Hence, counseling hypertensive patients on drug adherence, the need for vegetable consumption, doing moderate physical activity, and avoiding salt addition habit in meals are recommended to improve BP control.

Data sharing statement

Data will be available upon request from the correspondence authors.

Author contributions

YA wrote the proposal, coordinated the data collection activity, analyzed the data, and drafted the paper. DGL revised the proposal and participated in the data collection and analysis and manuscript writing. ATA revised the proposal and participated in data analysis and manuscript editing. All the authors read and approved the final manuscript.

Disclosure

The authors report no conflicts of interest in this work.

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